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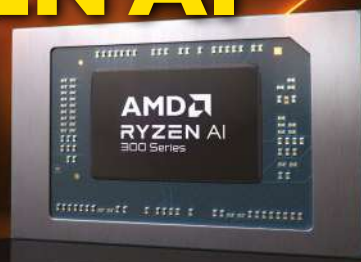
**PRO**

**AMD RYZEN AI**

**3 POWERFUL** laptops

**2 AWARD** winners

**1 ALL-NEW** processor



**FREE!** Norton Secure VPN worth £39.99 See page 66

# WINDOWS + MAC

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**WIN!**  
£2,200 Netgear  
Wi-Fi 7 router  
See page 77

**New AI skills on test ● Hidden features ● Shortcuts & time-savers**

FUTURE

**ISSUE 361**

BONUS SOFTWARE CODE Q7MYRJWAL

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**£10,000  
workstations**

**Stunning power for  
creative professionals**



**32in Samsung  
smart monitor**

**Work, rest and stream  
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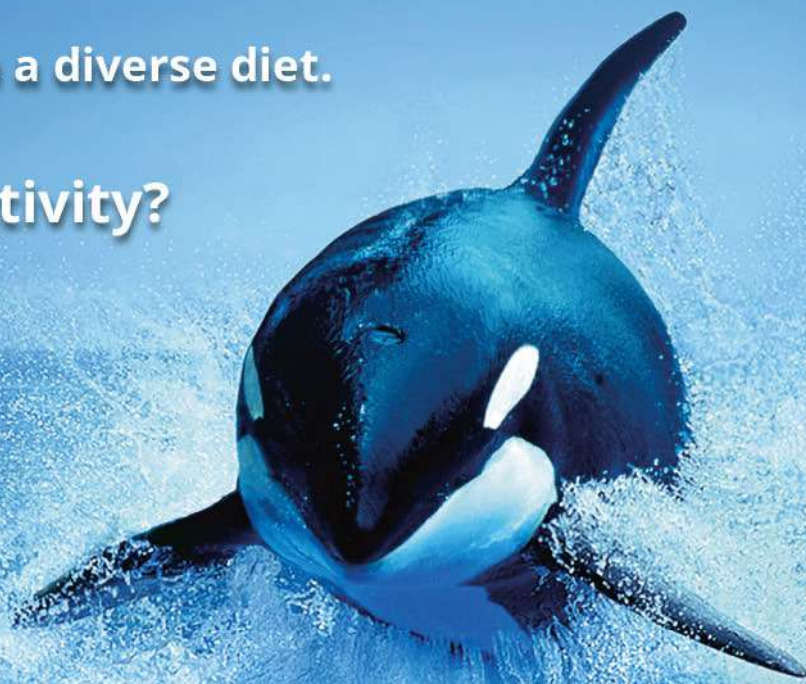
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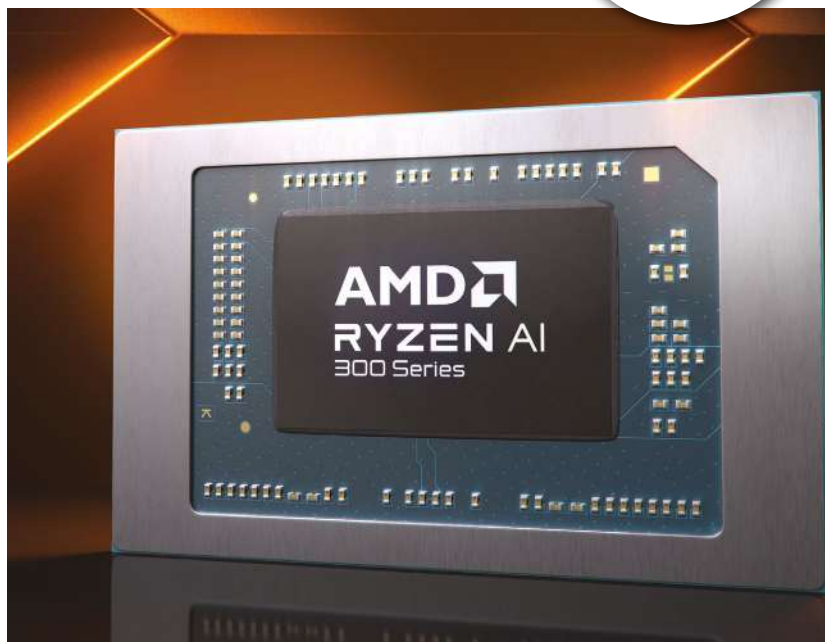
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## HIGHLIGHTS THIS MONTH

**WIN!**  
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Wi-Fi 7 router  
See page 77

Full contents overleaf



### REVIEW OF THE MONTH

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#### AMD Ryzen AI 300 Series

Chances are that the next laptop you buy will have AI skills inside, and AMD believes you should choose one of its trio of AI-enhanced chips. But, as we explain in our review, much else is new with the Ryzen AI 300 Series, with the debut of AMD's Zen 5 architecture, an integrated graphics chip that produces high frame rates and all-new compact cores. That's the theory covered: to see exactly what the new chips can do, we review three Asus laptops designed to take advantage of AMD's most advanced laptop processors.

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### WINDOWS UPDATES OF THE YEAR

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If you've never heard of BowieNet, you're in for a treat. As Bowie super-fan Lee Grant explains, in his golden years the rock star put rival ISPs under pressure. Even young Americans loved it.

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### FREE BOOSTER OF THE MONTH

Chances are that you (a) have some Wi-Fi dead spots in your home or office and (b) have an old router lying around. Darien Graham-Smith explains how (b) can solve (a) with a free upgrade.

### CAT OF THE MONTH

If there's one thing wrong about this magazine, it's the absence of cats and dogs in our pages. This month, in her quest to find pet translators that work, Nicole changes all that.

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### THE LABS IN ONE NUMBER

You can buy a lot of things for £10,000. A luxury safari in Kenya springs to mind, if anyone's offering. But that isn't an investment that will last for years and potentially slice rendering times in half – unlike the eight creative workstations on test from p78.

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# PC PRO

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- 2 AWARD winners
- 1 ALL-NEW processor



FREE! Norton Secure VPN worth £39.99

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# WINDOWS + MAC

## EVERY NEW FEATURE RATED

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**WIN!**  
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New AI skills on test • Hidden features • Shortcuts & time-savers

## LATEST REVIEWS

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**workstations**

Stunning power for  
creative professionals



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Work, rest and stream  
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# Microsoft's great expectations may lead it into hard times

**Y**ou may not realise that Charles Dickens wasn't merely a prolific novelist, journalist and short story writer, but also a keen reader of *PC Pro*. And a time traveller. When he wrote "It was the best of times, it was the worst of times", he was referring to the incredible slew of AI-enabled laptops that would launch in the summer of 2024, knowing the lost weekends and evenings it would cause me in my desperate attempt to review them all. Although I'm still not entirely happy about his depiction of me in *A Christmas Carol*.

This particular issue is a tale of two CPU architectures, with AMD the hero for x86 with its all-new Ryzen AI 300 series. I give my largely positive verdict on this launch from p48, and if you flick through the subsequent pages you'll discover two rather lovely Asus ProArt laptops that use them. The PX13 (see p50) is particularly desirable.

Then Arm comes along in the form of Qualcomm's Snapdragon chips, which are powering the first flotilla of Copilot+ PCs. This month

saw the debut of its Elite Plus incarnation in the Dell Inspiron 14 Plus (see p59), while the ever-stylish XPS 13 (see p58) had me gazing in wonder at its beauty and in disbelief at its screen. All before Lenovo took our new A List award for best Copilot+ PC with the sleek Yoga Slim 7x (see p57).

That's not the end of this month's AI-toting systems. UK manufacturer PCSpecialist hopes to lure buyers with a £749 price for its Lafite AI AMD (see p56), while three remarkably different laptops take advantage of Intel's Core Ultra chips – including a debut, with a twist, for Dell's new Latitude business series (see p63).

So it's safe to say PC manufacturers are excited about AI. The great British public? Not so much. Our readers' poll asking about people's attitudes towards AI (see p25) revealed roughly as much enthusiasm as when Bob Cratchit asked Scrooge for a day off. Safe to say that Microsoft et al have some persuading left to do.

If they're hoping that the forthcoming 24H2 update to Windows 11 will do the trick (see p26), then they may need to prepare

for disappointment. Having tried Cocreator and the live translation feature, plus the extra video effects built into Windows' webcam feeds, I just can't see people being swayed.

So what happens next? Dickens, master of the cliffhanger, has already worked on the narrative:

*Microsoft was a fat, healthy company; but it turned very pale. It gazed in stupefied astonishment on this small rebel group of customers for some seconds. "What!" wrote Microsoft on its blog, in a faint typeface.*

*"Please, Microsoft," commented the users, "we want some more."*

At this point Dickens' quill ran dry, and I believe he adapted the words for another piece of trashy literature, but you get the gist. Whether Microsoft likes it or not, we do demand more. Although if it could possibly avoid another deluge of laptops next month so that I can see my family again, that would be great.

**Tim Danton**  
Editor-in-chief

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## EDITORIAL

EDITOR-IN-CHIEF

Tim Danton editor@pcpro.co.uk

EDITORIAL FELLOW

Dick Pountain

ASSOCIATE EDITOR

Darien Graham-Smith

FEATURES EDITOR

Barry Collins

FUTURES EDITOR

Nicole Kobie

BONUS SOFTWARE EDITOR

Nik Rawlinson

## ART & PRODUCTION

ART DIRECTOR

Paul Duggan

FREELANCE DESIGN

Bill Bagnall

PRODUCTION EDITOR

Steve Haines

## CONTRIBUTING EDITORS

Stuart Andrews

Steve Cassidy

Lee Grant

Dave Mitchell

Jon Honeyball

Rois Ni Thuama

Olivia Whitcroft

Davey Winder

## CONTRIBUTORS

Tom Bedford

David Crookes

Rael Hornby

Paul Hutton

James Morris

## ADVERTISING

GROUP ADVERTISING MANAGER

Ben Topp: ben.topp@futurenet.com

ADVERTISING MANAGER

Alexandra Thomas:

alexandra.thomas@futurenet.com

## PRODUCTION

SENIOR PRODUCTION MANAGER

Lawrence Brookes

## CIRCULATION & SUBSCRIPTIONS

CIRCULATION MANAGER

Emma Read

SENIOR CAMPAIGN MANAGER

Juber Ahmed

DIRECT MARKETING EXECUTIVE

Lewis Smythe

## LOGOS & REPRINTS

ENDORSEMENT LICENSING MANAGER

Ryan Chambers:

ryan.chambers@futurenet.com

As PC Pro recently celebrated its 30th anniversary, we wondered – is there anything “techie” that you’re still using from 1994 or before?

“I bought them in 1997 rather than 1994, but if you watch the PC Pro podcast live then you’ll see my Sennheiser HD 565 Ovation headphones. One earpiece keeps dropping off, but the sound is still amazing.”

“Pre-1994 technical objects I still use are mostly analog: Dunlop Systemdek II vinyl turntable; Castle Kendal speakers (re-coned); Sony CDP-312 CD player; and 1986 MIJ Fender Stratocaster guitar.”

“1994 was the year I went up to university and, for the first time, had my own email account. I’m not going to tell you what it was, as I still have dreams of one day going back and reclaiming it.”

“The only thing I’m still using from pre-1994 is my muscle memory. Ctrl+C to copy, Ctrl+V to paste, etc. Amazing that decisions made all those years ago still stick, and that it would be unthinkable to change them now.”

“I still have some CompactFlash camera memory cards from the 1990s. On the rare occasion I come across an old camera that uses the format they still come out to play.”

“I have quite a lot of Psion kit. The Organiser II was launched in 1986, and mine all still work, especially when I power them with a modern lithium-ion PP9 battery. I even have the Spreadsheet add-on module.”

“I have a small collapsible table made in the 1960s by my Grandfather. The clever tech is a sprung-wood release mechanism, fabulously designed and engineered by the old boy. Still in constant use by a fourth generation of Grants.”

“My Dad’s slide rule and a Recaro office seat. And I think that’s it.”

“The information superhighway.”

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## PRODUCTION & DISTRIBUTION

Printed by Walstead Roche.

Distributed by Marketforce (UK) Ltd, 121-141 Westbourne Terrace, London W2 6JR.

Email: mfcommunications@futurenet.com.

PC Pro is produced by Danton Media Limited and published monthly by Future plc.

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# Briefing

Background and analysis on all the important news stories

## Intel's chips leave bad taste for PC buyers

Raptor Lake woes create problems for buyers and sellers alike

**P**C buyers and vendors alike are troubled after Intel belatedly admitted to problems with its 13th and 14th generation desktop processors.

There have long been reports of instability with Intel's "Raptor Lake" processors, with systems crashing under heavy load, and even dead chips. Intel finally released a microcode patch for the processors in August, throttling back the voltage available to the chips to prevent systems hanging and permanent damage to the processor.

That's far from the end of the matter, though, with unhappy PC buyers worried their processors may already be irreparably damaged and PC vendors bearing the brunt from disgruntled customers.

### ■ The long road to remediation

Reports of problems with the Intel processors have been swirling since late 2022, particularly among the overclocking community, who are most likely to trigger the potentially damaging voltages.

Intel had remained tight-lipped on the issue until late July, when it finally admitted that 13th and 14th generation desktop processors with 65W or higher base power "could be

affected by elevated voltage issues". Worse, chips could be irreparably damaged by the excess voltage.

It followed up with the microcode patch in mid-August, but as this patch can't be distributed via Windows Update, it's reliant on either PC manufacturers contacting affected customers or buyers seeking out the BIOS update by themselves.

Even if the patch is applied, some customers remain worried the damage to their processor may not be immediately apparent. "I've experienced this exact same issue with my i9 14900KF," wrote one PC buyer on Reddit.

"[It] worked fine for almost three months after purchase. Then games started crashing. All of them. I also started to see Windows kernel errors in the event logs."

The commenter added that "the danger is that the fixes I've used don't last and that it fails completely – once the warranty is over, of course".

It's not only consumers who've been affected by the flaws. "There's been a higher than usual incidence of customers reporting PC instability on i9 and i7 chips – especially from corporate customers who use these systems intensively, like games developers, research companies and the like," said Ben Miles, consultant

**ABOVE Raptor Lake processors are causing some systems to crash**

and former managing director of a major UK-based system builder.

"The problem is exacerbated by workloads that are driving the systems really hard, surely the tasks the i9 was built for? We've also seen more chips than usual fail stringent pre-shipping testing, and have actually stopped using some stress tests because of the severe load they put on the chips for fear of damaging them before they get to the customer."

The bugs with the Intel chips are prompting customers to look elsewhere, according to Miles. "With this instability time bomb, and the fact the 'fixes' so far nerf the performance, we've seen multiple customers decide to move to AMD Ryzen chips," he said.

"The 'speed at all costs' mantra of Intel's chip design has not been sustainable for a long time. Pushing 350W through a chip the size of a first-class stamp is not sensible and this feels like a classic case of the chickens coming home to roost."

“There's been a higher than usual incidence of customers reporting PC instability on i9 and i7 chips”

### ■ Vendor concerns

A spokesperson for another British PC vendor, who spoke to *PC Pro* on the condition of



anonymity, claimed that system sellers were being increasingly confronted by customers who are worried their PC has been affected by the bug. Although the actual number of processor failures caused by the Raptor Lake flaw was modest, the increased publicity about the problem was causing concerned customers to contact support, with some demanding refunds on their PCs.

The vendor also expressed concern about the two-tier warranty system that Intel operates. Customers who buy retail CPUs from Intel are covered by a three-year warranty, but OEM CPUs come with only a single year's warranty. Intel has now promised to extend the warranty on retail CPUs to five years, but it's unclear if OEM warranties will also be extended, the vendor told us, meaning vendors could be left out of pocket if forced to refund or repair customers' PCs.

The spokesperson said they were also getting "mixed reports on how effective those microcode updates are", meaning the problem may not be fixed even for those customers who are aware of the BIOS update.

Intel declined to directly answer questions about extending OEM warranties or the effectiveness of its microcode

updates. It instead pointed us to its previously released press statement, in which it reaffirmed its "confidence in its products" and said it was "committed to making sure all customers who have or are currently experiencing instability symptoms on their 13th and/or 14th gen desktop processors are supported in the exchange process.

"Users experiencing consistent instability symptoms should reach out to their system manufacturer (OEM/ System Integrator purchase), Intel Customer Support (boxed processor), or place of purchase (tray processor) [for] further assistance," the firm added.

## Intel woes

The ongoing problems with Raptor Lake processors are not even close to the company's biggest headache. Intel recently announced it was shedding 15,000 jobs, around 15% of its workforce, in a bid to put the firm on a more stable financial footing.

The job cuts announcement saw the company's share price immediately drop by 25%. At the time of writing, Intel's share price was less than a third of what it was only three years ago, when spiking demand for PCs during the Covid pandemic boosted the company's income.

**“Problems with the Raptor Lake processors are not even close to the company's biggest headache”**

# Boost for esports students

New lab offers cutting-edge facilities in Salford

**T**he UK's burgeoning esports studies scene has been overclocked with a new lab opening at the University of Salford.

Salford's Business School is among a host of UK universities now offering esports courses, including Staffordshire University, the University of Chichester and Falmouth University.

Salford's course differs slightly from some others in that it focuses on esports business management, nurturing students' ability to run esports events rather than compete in them directly. The Salford HND course is only in its second year of operation, but students will now benefit from the state-of-the-art lab, which course leaders say will let students learn on the same kind of equipment used at professional esports events.

The new lab comprises 23 Yoyotech i9 RTX Esports Gaming PCs, fitted with high-end Intel processors (hopefully not those mentioned opposite) and Nvidia RTX 4080 Super graphics cards. The lab has a six-seat tournament space, as well as equipment to stream competitions. It also has a Formula 1 licensed racing simulator, the same type of equipment that F1 drivers use for training.

Iain Earle, programme leader for the course, said it's vital that students have access to the level of equipment being used in the industry. "My background is actually in the creative music industry, and I understand from the creative process just how important it is to have the right kind of professional atmosphere,

professional equipment and, as much as possible, the latest kit," he said.

"The general idea is to provide a workshop space for them that would be conducive to what they would expect in industry."

It's not only having the right equipment that's vital, but the right teaching staff. For an emerging academic subject such as esports, that means having to recruit outside of the normal bounds of academia. "It's really important that the team in front of the students knows what they're talking about, because so many times these young people know their stuff beyond anything we've probably seen before," said Earle.

"What I found is the best place to find teachers is from the [esports] community rather than some universities who went out and started an esports course and kind of bolted a few existing programmes and modules together with the team that they had."

Earle expects more universities to start offering esports courses in short order. "It's part of a big cultural phenomenon, and I think this [lab] is going to push interest, and also going to push demand into university courses around the country."

**RIGHT/BELOW** The lab at Salford University is using cutting-edge kit to teach students



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## CrowdStrike: will anything really change?

It's been described as the world's biggest IT failure. **Barry Collins** investigates whether any lessons will be learned

**W**as the CrowdStrike meltdown the worst IT failure in history? Probably, but nobody really cares about its level of notoriety. What they care about is their flight leaving on time, or their hospital appointment going ahead, or being able to log in to online banking. For a good few hours on 19 July 2024, none of those things was a given for millions of people around the world.

The incident reports have been written, the lawsuits filed and in-depth articles about why it happened written (see the columns by Jon Honeyball and Davey Winder this month, p110 and p118). But will the lessons of the CrowdStrike failure be learned to minimise the possibility of a similar incident ever occurring again? Right now, it's hard to tell. Indeed, some experts fear it could have a detrimental effect on IT security.

### Pinpointing the fault

It certainly seems that the precise fault that caused CrowdStrike's software to bring down in excess of 8.5 million PCs worldwide is unlikely to reoccur. The company's preliminary incident report, published in mid-August, details over 12 pages what went wrong and how the company plans to address it.

In February, CrowdStrike's Falcon sensor introduced a new template type to detect certain types of attacks on Windows PCs. This template required the software to interpret 21 different inputs to make detection decisions. However, an error led to the software only being programmed to handle 20.

When that fateful update was released on 19 July, it was the first to require all 21 inputs to be checked. The CrowdStrike software attempted to process the missing 21st input and that created an out-of-bounds memory access that resulted in the Blue Screen of Death on affected PCs.

CrowdStrike is taking several measures to ensure there's no repeat, as you would expect from a company that's lost around a third of its value since the incident and is likely to face several legal claims for compensation. A runtime check is being added to its Content Interpreter to ensure that it doesn't try to read beyond the available input array; testing has been stepped up to ensure that the number of inputs matches what is expected; and the company is giving customers greater control over when to implement updates, hopefully ensuring whole fleets of PCs don't go down simultaneously if a similar error managed to creep through.

In a very public show of contrition, CrowdStrike president Michael Sentonas showed up in person at DEF CON's annual Pwnie Awards to collect the gong for "most epic fail". "We got this horribly wrong," Sentonas said, "and it's super important to own it."

He said he'd take the giant trophy he was presented and display it prominently back at HQ "because I want every CrowdStriker who comes to work to see it" so that "everyone understands these things can't happen". He was given a warm ovation for fronting up, but CrowdStrike isn't the only company facing questions about its procedures.

### Spotlight on Windows

Although CrowdStrike's software was pinpointed as the cause of the 19 July outage within a couple of hours of it occurring, some believe Microsoft has questions to answer about the stability of its operating system, too. How was it possible that such an error managed to drag down Windows PCs and servers in the first place, often requiring technicians to physically attend the system to remediate the flaw?

The fact that security software has kernel-level access was identified as

## A little bit of history repeating

CrowdStrike probably had a bigger impact than any IT outage in history, but it's had strong competition, not least from McAfee almost 15 years ago.

McAfee's 2010 blunder bore a striking resemblance to CrowdStrike. The firm released an antivirus update that inadvertently flagged a critical Windows file (svchost.exe) as a malicious threat. Affected machines entered a reboot

cycle, and its effect was felt in government agencies, hospitals and beyond. McAfee issued an emergency fix and instructions on how to manually restore affected systems.

There's another similarity between the two incidents. McAfee's chief technology officer during the 2010 blunder, George Kurtz, is now the CEO of CrowdStrike. There is, of course, no suggestion that is anything other than a desperately unfortunate coincidence, but if you're the man involved, well... that's gotta Kurtz.



**RIGHT** McAfee's CTO in 2010, George Kurtz, is now the CEO of CrowdStrike



## Recovery

It looks like Windows didn't load correctly

If you'd like to restart and try again, choose "Restart my PC" below. Otherwise, choose "See advanced repair options" for troubleshooting tools and advanced options. If you don't know which option is right for you, contact support or a Microsoft Store technician to help with this.

See advanced repair options

Restart

one of the key reasons for the failure. Critics pointed to the fact that Apple doesn't give third-party providers such elevated access in macOS.

That criticism prompted an unnamed Microsoft spokesperson to put out a spiky defence, telling the *Wall Street Journal* that it "cannot legally wall off its operating system in the same way Apple does because of an understanding it reached with the European Commission following a complaint".

This is believed to refer back to a 2009 agreement reached with the EU, where Microsoft agreed to give third-party security firms the same level of access as its own security software, to head off complaints that it was giving its own products an unfair advantage.

Microsoft's argument didn't convince some experts. Dr Ian Brown, an independent consultant on internet regulation and previously the principal scientific officer for the Department for Digital, Culture, Media and Sport (DCMS), rubbished the suggestion that Microsoft's hands were bound by EU edicts. "This is, technically speaking, total [poop emoji]," Brown wrote on his blog.

"There is no good reason why security-critical features in the Windows 'kernel' used by Microsoft's own security products cannot be documented and made available to competitors' security products, with appropriate controls."

Others argue that the issue of access to the kernel is a red herring. "The big thing here is testing," said Bola Rotibi, chief of enterprise research at CCS Insight. "What kind of testing did they [CrowdStrike] do or did they not do? I don't think this is access. This is testing."

"I can't imagine that Microsoft is not going through its own internal reviews. So it's probably going to be asking itself, what can it do to make sure that that doesn't happen with other third-party solutions? Because that's what it should be doing. Not putting the barriers up, because that's not good for anyone."

Security firms agree that kicking third-party software out of the kernel won't necessarily make Windows more robust. "There's this illusion going around that you can't blue screen a machine if you don't run as a driver," said Danny Jenkins, a former ethical hacker and now CEO of security firm ThreatLocker. "That's complete crap."

**ABOVE** The dreaded Blue Screen of Death was witnessed the world over in July

lashed out at both CrowdStrike and Microsoft, for example, and is filing a damages lawsuit on behalf of passengers who were affected.

CCS Insight's Bola Rotibi believes the CrowdStrike incident should be treated like a major incident. "If you look at any other industry, things improve after there are challenges or disasters," she said. "I came from the engineering world. They sat us down and we watched the Piper Alpha [oil platform] disaster. It's one of those lessons that all engineers go through once."

"If you don't do that investigation, you cannot learn from it, you cannot prevent it again."

Danny Jenkins argues more radical change is required, including a complete change in the mindset of IT security. "The way that people have typically secured their servers is they've basically said, 'I'm going to put a security product on there, and we're going to look for everything bad on the server'. And the challenge with that is, one, you can't find everything bad, which is why we get ransomware attacks."

**“What kind of testing did CrowdStrike do or did they not do? I don't think this is access. This is testing”**

But more importantly, CrowdStrike does about 12 updates a day that are necessary just to keep up with the bad guys, and then still losing.

"I think the way it should change is companies should start approaching security from a ZT [zero trust] basis... because if you lock down servers, particularly to block everything except what you run...

you're better off because you're not doing 12 updates a day in order to secure your system."

However, Jenkins claims that far from bolstering their security, he's seen evidence of firms putting off security updates since CrowdStrike. "Now we've got this fear built into IT professionals' minds of 'if I secure my server, I might take my server down. If I don't secure my server, I might take my server down. What am I supposed to do?'"

As Jenkins points out, if "20% of the world turn off Windows updates, there will be a crapload of malware attacks that don't make the news. At the end of the day, the number of computers taken down by ransomware in the last year is multiples of what was taken down by the CrowdStrike outage."

"If they were running at the user level and they killed service hosts, which is what McAfee did 15-20 years ago, when they blue screened a lot of machines... it would be the same scenario..." As we cover in "A little bit of history repeating", opposite.

### ■ What now?

Even if there's no silver bullet to prevent another global IT outage, Microsoft will certainly be keen to avoid a repeat. Although most of the reputational damage was incurred by CrowdStrike, it's hardly been a PR win for Windows. Delta, one of the airlines most badly affected by the incident, has publicly

# The A-List



The best products on the market, as picked by our editors

## PREMIUM LAPTOPS

### Apple MacBook Pro 16in (2023)

**M3 power from £1,699**  
from [apple.com](https://apple.com)

The M3 chips give the already brilliant MacBook Pro series a boost in games with no sacrifices elsewhere, so power users who are happy with Apple must grapple with the big decisions: which M3 chip, which size of screen, and how much RAM and storage?

**REVIEW** Issue 352, p46



## BUSINESS LAPTOPS

### Lenovo ThinkPad T14s Gen 6 (Snapdragon)

**Copilot+ PC for £1,500 exc VAT**  
from [lenovo.com](https://lenovo.com)

It's perhaps a controversial choice – and we wouldn't roll this out en masse – but if you're buying for executives or CTOs this cutting-edge Copilot+ PC, complete with a Qualcomm Snapdragon Arm processor, is a superb choice. Not only is it good value, it's light, it's fast and its all-day battery life is genuinely 24 hours.

**REVIEW** Issue 360, p56



## NEW ENTRY

### Apple Mac Book Air13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299** from [apple.com](https://apple.com)

**REVIEW** Issue 356, p54

### Huawei MateBook X Pro (2024)

Despite weighing only 980g, this laptop packs a 14.2in OLED panel, 2TB of storage and an 11-hour battery life, as well as an Intel Core Ultra 9 processor. **£2,100** from [consumer.huawei.com](https://consumer.huawei.com)

**REVIEW** Issue 358, p60

### Asus ProArt PX13

With AMD's new Ryzen AI 9 HX 370 inside, this 1.4kg compact powerhouse offers incredible amounts of power. Add a fantastic OLED screen and RTX 4070 graphics and it's a winner. **From £2,000** from [uk.store.asus.com](https://uk.store.asus.com)

**REVIEW** Issue 361, p50

## NEW ENTRY

### Lenovo ThinkPad X1 Carbon Gen 12

The X1 Carbon range has stepped up a gear thanks to Intel's Core Ultra chips, and Lenovo matches it with the stunning build quality and keyboard you'd expect. **From £1,375** from [lenovo.com](https://lenovo.com)

**REVIEW** Issue 358, p58

### Dell Latitude 9450 2-in-1

This 14in convertible, based around Core Ultra CPUs, lacks for nothing, whether that's speed, battery life (around 16 hours), build quality or flexibility. **From £1,560 exc VAT** from [dell.co.uk](https://dell.co.uk)

**REVIEW** Issue 361, p63

### HP Dragonfly G4

It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives. **From £1,380 exc VAT** from [hp.com](https://hp.com)

**REVIEW** Issue 352, p58

## COPILOT+ PCs

## NEW ENTRY

### Lenovo Yoga Slim 7x (Gen 9)

**AI on demand, £1,350**  
from [lenovo.com](https://lenovo.com)

You won't find a better-value laptop, never mind one that meets the Copilot+ PC criteria. With a Snapdragon X1E-78-100 inside it isn't the fastest in benchmarks, but it's incredibly nippy in practice, the battery lasts over 16 hours and the 14.5in OLED screen is top quality.

**REVIEW** Issue 361, p57



## EVERYDAY LAPTOPS

### Acer Aspire 14 A14-51GM

**Compact power for £850**  
from [acer.com](https://acer.com)

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price.

**REVIEW** Issue 359, p82



## NEW ENTRY

## NEW ENTRY

## NEW ENTRY

### Samsung Galaxy Book4 Edge

A classy 16in laptop that weighs 1.6kg, uses the fastest Snapdragon Elite X chip and delivers a solid 12 hours of battery life. **£1,499** from [samsung.com](https://samsung.com)

**REVIEW** Issue 360, p53

### Microsoft Surface Laptop, 7th Edition

The poster child for Copilot+ PCs offers quality, great looks and staggering battery life. **From £1,049** from [microsoft.com](https://microsoft.com)

**REVIEW** Issue 360, p50

### Asus Zenbook S 15 OLED

With a price drop to £1,200 this 15.6in laptop becomes a viable competitor to the Yoga Slim 7x if you need a bigger screen. **£1,200** from [uk.store.asus.com](https://uk.store.asus.com)

**REVIEW** Issue 359, p52

### Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099** from [uk.store.asus.com](https://uk.store.asus.com)

**REVIEW** Issue 359, p58

### Framework Laptop 13 (DIY Edition)

With a competitive price, modular approach and easy-to-repair ethos, you can pick and mix your perfect 13in laptop. **From £779** from [frame.work](https://frame.work)

**REVIEW** Issue 360, p58

### Huawei MateBook D16

It's big and certainly not bashful, packing an Intel Core i9 chip and a high-quality 16in panel – and surprisingly good battery life, too. **£1,000** from [huawei.com](https://huawei.com)

**REVIEW** Issue 359, p87



## CHROMEBOOKS

### Acer Chromebook Spin 714

Flipping great for £799

from [currys.co.uk](https://www.currys.co.uk)

Simply the best Chromebook around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this convertible for £799.

**REVIEW** Issue 356, p83



### Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from [currys.co.uk](https://www.currys.co.uk)**

**REVIEW** Issue 356, p82

### Lenovo IdeaPad 5i Gaming Chromebook Plus

The 120Hz 15.6in display is the star of this Chromebook, as it should be with 2,560 x 1,600 pixels to play with. You're getting a lot of laptop for the price, too, including a 512GB SSD, Core i5-1235U processor and 8GB of RAM. Just note the 1.9kg weight.

**£659 from [very.co.uk](https://www.very.co.uk)**

**REVIEW** Issue 356, p88

## MINI PCs

NEW ENTRY

### Apple Mac mini (2023)

M2 masterpiece from £649

from [apple.com](https://www.apple.com)

The outside remains the same, but this simple yet effective update to the Mac mini introduces the M2 and M2 Pro processors with predictable effect. The entry-level price quickly rises once you start upgrading – moving from 8GB to 16GB costs £200, as does doubling the base storage from 256GB to 512GB – but there's enough power here to last you for years.

**REVIEW** Issue 343, p60



### Geekom A8 Mini PC

Geekom makes brilliant use of AMD's Ryzen 9 8945HS in this powerful mini PC, which occupies little more desktop space than a drinks coaster. And it still packs every port most people need, plus Wi-Fi 6E. If you don't need this much power (or 32GB of RAM and a 2TB SSD) the Ryzen 7 version is £719.

**Ryzen 9, £899 from [geekom.co.uk](https://www.geekom.co.uk)**

**REVIEW** Issue 359, p62

### MSI Cubi NUC 1M

One of the most versatile mini computers we've seen and available in barebones or fully configured, the power-efficient Cubi is based around Intel's latest Core processors. With Thunderbolt 4, lots of storage options and two 2.5GbE connections, there's very little it can't do. **Barebones,**

**from £349 from [scan.co.uk](https://www.scan.co.uk)**

**REVIEW** Issue 361, p64

## ENTHUSIAST PCs

### CyberPowerPC Ultra R77 RTX Gaming PC

RTX Super 4080 power for £2,275

from [tinyurl.com/356cyber](https://www.tinyurl.com/356cyber)

The striking case catches the eye, but it's the potency of AMD's Ryzen 7 7800X3D and Nvidia's RTX 4080 Super graphics that leave the lasting effect.

**REVIEW** Issue 356, p62



### CyberPowerPC Infinity X145 Elite

Designed to deliver the maximum possible gaming power for £999, this Core i5-14400F system – with 32GB of DDR5 RAM and GeForce RTX 4060 graphics – is a great machine now with potential for more later. **£999**

**from [tinyurl.com/360cyber](https://www.tinyurl.com/360cyber)**

**REVIEW** Issue 360, p61

### Palicomp AMD Destiny

An incredibly fast gaming PC for the money thanks to the wicked combination of AMD's Ryzen 7 7800X3D and Nvidia's GeForce RTX 4070 Super. With a fast 1TB SSD and 32GB of RAM in support, it's enough for smooth 4K gaming. **£1,249 from**

**[palicomp.co.uk/destiny-mag1](https://www.palicomp.co.uk/destiny-mag1)**

**REVIEW** Issue 360, p60

## ALL-IN-ONE PCs

### HP Envy 34 All-in-One

£2,099 widescreen wonder

from [hp.com](https://www.hp.com)

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

**REVIEW** Issue 335, p46



### Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

**From £599 from [dell.co.uk](https://www.dell.co.uk)**

**REVIEW** Issue 350, p47

### Apple iMac 24in (M3)

The iconic design remains the same, but the plain M3 chip inside the revamped iMac 24in is a revelation compared to the previous M1 version. The downside is that the base configuration includes a stingy 8GB of memory and a 256GB SSD.

**From £1,399 from [apple.com](https://www.apple.com)**

**REVIEW** Issue 352, p52

## CREATIVE WORKSTATIONS

NEW ENTRY

NEW ENTRY

NEW ENTRY

### Armari Magnetar M64T7-AW1650G4

Threadripping power for £8,329 exc VAT

from [armari.com](https://www.armari.com)

AMD's Ryzen Threadripper 7980X is the star of this particular show, dominating our benchmarks with the help of 128GB of RAM, two 2TB Crucial PCI-E 5 drives in RAID0 configuration and AMD's Radeon Pro W7800 professional GPU. And it's all wrapped up in a custom Armari case with liquid cooling.

**REVIEW** Issue 361, p92



### PCSpecialist Quantum Goliath R

Extracting maximum power from its budget by opting for consumer components with professional levels of power, this well-thought-out workstation couples Intel's Core i9-14900KS with RTX 4090 graphics to tremendous effect. **£3,750 exc VAT**

**from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)**

**REVIEW** Issue 361, p89

### Scan 3XS GWP A1-TR64

A more balanced offering than Armari's Magnetar, Scan mixes a Threadripper 7970X with Nvidia RTX 5000 graphics – and a stunning supporting cast of components with an equally stunning case. Perfect for real-time viewsets and GPU accelerated computation.

**£7,917 exc VAT from [scan.co.uk](https://www.scan.co.uk)**

**REVIEW** Issue 361, p94



## TABLETS

### Apple iPad Air (M2)

**M2 power from £599**  
from [apple.com](https://apple.com)

We love the new iPad Pro, but for most people the M2 iPad Air is not only far better value but also all the tablet they'll need. It supports the Magic Keyboard and Pencil Pro, plus it's now available in both 11in and 13in sizes.

**REVIEW** Issue 358, p50



### Apple iPad Pro (M4)

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from**

**apple.com**  
**REVIEW** Issue 358, p48

### OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.

**£449 from [oneplus.com](https://oneplus.com)**  
**REVIEW** Issue 352, p86

## EVERYDAY PHONES

### Motorola Moto G54 5G

**Great looker for £180**  
from [johnlewis.com](https://johnlewis.com)

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.

**REVIEW** Issue 355, p77



### Google Pixel 8a

We're fans of the Pixel 8 but you can save £200 and buy the 8a without missing out on any key features, including its advanced AI skills thanks to the same Tensor G3 chip inside. It's only when you zoom into snaps that you spot the camera quality difference.

**128GB, £499 from [store.google.com](https://store.google.com)**  
**REVIEW** Issue 358, p74

### Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too.

**128GB, £364 from [johnlewis.com](https://johnlewis.com)**  
**REVIEW** Issue 358, p77

## PREMIUM PHONES

### Samsung Galaxy S24 Ultra

**AI cleverness from £1,249**  
from [samsung.com](https://samsung.com)

The undeniably high price gets you a bunch of AI tools that will genuinely save you time (and money). While we miss the 10x optical zoom of the S23 Ultra, the 5x zoom camera and supporting cast capture brilliant images, while the S Pen is always on hand to scrawl notes and pictures.

**REVIEW** Issue 354, p58



### Google Pixel 8

It's not a huge step up from the Pixel 7, but the added AI features are genuinely useful and it benefits from a handful of upgrades, too – including a 120Hz screen and the new Tensor G3 processor. If you don't mind the lack of optical zoom, it's a great buy for the price.

**128GB, £699 from [store.google.com](https://store.google.com)**  
**REVIEW** Issue 351, p72

### Motorola Razr 50 Ultra

Not merely a huge upgrade over last year's Razr 40 Ultra, this new model also leapfrogs over Samsung's new Flip6 to become our flip phone of choice. That's thanks to its great battery life, superb screens (particularly on the outside) and a camera that's a joy to use.

**£1,000 from [motorola.co.uk](https://motorola.co.uk)**  
**REVIEW** Issue 360, p88

## EVERYDAY MONITORS

### Iiyama ProLite XUB3293UHSN-B5

**32in 4K bargain, £429**  
from [currys.co.uk](https://currys.co.uk)

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (see below) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.

**REVIEW** Issue 357, p88



### AOC Q27B3CF2

AOC's relentless focus on value delivers a 27in 1440p screen with a high-quality IPS panel that costs £200 including VAT – and also packs in a USB-C port. Those are almost the only features you get, and the OSD is awful, but at this price we're not complaining.

**£200 from [amazon.co.uk](https://amazon.co.uk)**  
**REVIEW** Issue 360, p77

### Acer Verso B277 Ebmiprxxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub.

**£149 from [tinyurl.com/357acer277](https://tinyurl.com/357acer277)**  
**REVIEW** Issue 357, p84

## PROFESSIONAL MONITORS

### Eizo FlexScan EV3240X

**Stunning 4K quality, £1,206**  
**exc VAT from [photospecialist.co.uk](https://photospecialist.co.uk)**

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.

**REVIEW** Issue 357, p91



### Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too.

**£2,149 exc VAT from [wexphotovideo.com](https://wexphotovideo.com)**  
**REVIEW** Issue 357, p90

### BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts.

**£333 exc VAT from [scan.co.uk](https://scan.co.uk)**  
**REVIEW** Issue 357, p86



## WEBCAMS

### Logitech MX Brio 705 for Business

Consistent brilliance for £219

from [logitech.com](https://www.logitech.com)

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.

**REVIEW** Issue 356, p68



### Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.

**£45 from [logitech.com](https://www.logitech.com)**  
**REVIEW** Issue 360, p77

### Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.

**£329 from [amazon.co.uk](https://www.amazon.co.uk)**  
**REVIEW** Issue 352, p75

## HOME OFFICE PRINTERS

### Epson EcoTank ET-2830

Ink tank all-in-one for £250

from [epson.co.uk](https://www.epson.co.uk)

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.

**REVIEW** Issue 353, p85



### Canon Pixma TS8750

A fantastic choice for creative users that's equally at home printing photos as it is scanning artwork. Despite its high running costs, due to its reliance on cartridges, this is a superb all-in-one. **£159 from [printerbase.co.uk](https://www.printerbase.co.uk)**

**REVIEW** Issue 353, p86

### HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.

**£208 from [printerland.co.uk](https://www.printerland.co.uk)**  
**REVIEW** Issue 353, p87

## WORKGROUP PRINTERS

### Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from [canon.co.uk](https://www.canon.co.uk)

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.

**REVIEW** Issue 350, p58



### Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from [printerland.co.uk](https://www.printerland.co.uk)**

**REVIEW** Issue 353, p84

### Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from [printerbase.co.uk](https://www.printerbase.co.uk)**

**REVIEW** Issue 341, p87

## WIRELESS ROUTERS

### Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from [amazon.co.uk](https://www.amazon.co.uk)

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.

**REVIEW** Issue 341, p68



### Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.

**£800 from [netgear.com](https://www.netgear.com)**  
**REVIEW** Issue 353, p76

### Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support. **£125 from [uk.store.asus.com](https://www.uk.store.asus.com)**

**REVIEW** Issue 350, p57

## MESH WI-FI

### TP-Link Deco XE200

Clever Wi-Fi 6E for £600

from [amazon.co.uk](https://www.amazon.co.uk)

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPCW8) should be enough for most premises.

**REVIEW** Issue 349, p65



### Mercusys Halo H80X

A new subsidiary of TP-Link, Mercusys offers its parent brand's XE75 router some excellent value-for-money competition. Not as fast due to Wi-Fi 6 rather than Wi-Fi 6E, but it has all the bandwidth you need for everyday use and should deliver it stably throughout your house. There are plenty of features too. **2-pack, £161 from [ebuyer.com](https://www.ebuyer.com)**

**REVIEW** Issue 341, p71

### Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from [amazon.co.uk](https://www.amazon.co.uk)**

**REVIEW** Issue 350, p54



## BUSINESS WI-FI

### Zyxel WAX640S-6E Wi-Fi 6E AP, £369 exc VAT

from broadbandbuyer.com

A nicely priced tri-band wireless access point ideally suited to businesses that want to provide the full range of wireless services. It's easy to deploy, wireless performance is good and Zyxel provides top-quality cloud management services.

**REVIEW** Issue 353, p100



### TP-Link Omada EAP783

This slim-line discus has a mighty BE19000 rating and will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers superb performance and is MLO-ready, while TP-Link's Omada cloud platform offers great remote management services.

**£520 exc VAT from senetic.co.uk**

**REVIEW** Issue 360, p103

### Ruijie Reyee RG-RAP2260(E)

This competitively priced Wi-Fi 6 AP delivers business-class features and impressive performance, and the free Ruijie Cloud service offers a wide range of remote network management and monitoring tools.

**£160 exc VAT from broadbandbuyer.com**

**REVIEW** Issue 359, p103

## NAS SERVERS

### Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.

**REVIEW** Issue 346, p101



### Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs.

This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps.

**Diskless, £3,292 exc VAT from broadbandbuyer.com**

**REVIEW** Issue 344, p96

### Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features.

**5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com**

**REVIEW** Issue 344, p98

## VIDEOCONFERENCING

### Owl Labs Meeting Owl 4+ Magical meetings, £1,665 exc VAT

from owllabs.co.uk

For fully immersive meetings, nobody does it better than Owl Labs. The Owl 4+ sports a new 64MP fish-eye camera that boosts video output to 4K Ultra HD while keeping super-smooth speaker tracking. Pairing it with an Owl Bar covers every meeting room angle.

**REVIEW** Issue 360, p102



### Poly Studio X52 with TC10

Ideal for businesses that want a professional videoconferencing solution for medium-sized meeting rooms. Video quality is excellent, speaker tracking is exceptionally fast, and the big choice of built-in VC apps makes it incredibly versatile too.

**£3,161 exc VAT from meetingstore.co.uk**

**REVIEW** Issue 353, p102

### Jabra PanaCast 50

This sleek cylinder delivers great video and audio quality, fast speaker tracking and a wealth of advanced features. Jabra's Xpress web portal offers smart remote management services, and the super-wide view helps make the PanaCast 50 ideal for all-inclusive meetings.

**£867 exc VAT from uk.insight.com**

**REVIEW** Issue 354, p100

## SCANNERS

### Xerox N60w Pro Scanner

Speed demon, £766 exc VAT

from tradescanners.com

The N60w Pro offers tremendous value and versatility. It delivered up to 67ppm in our tests with great output quality, offers a plethora of connection options and makes walk-up scanning a breeze.

**REVIEW** Issue 358, p101



### Brother ADS-4500W

Ideal for small businesses, the ADS-4500W offers a fine set of walk-up scan features and its output quality is beyond reproach, while Brother's Print&Scan app delivers great scan workflow management options.

**£295 exc VAT from printerbase.co.uk**

**REVIEW** Issue 358, p98

### Epson WorkForce ES-C320W

A space-saving wireless desktop scanner, the Epson WorkForce ES-C320W delivers nippy speeds – around 31ppm in our tests – and is backed with software that offers plenty of scan management features.

**£180 exc VAT from printerland.co.uk**

**REVIEW** Issue 358, p100

## SERVERS

### Dell EMC PowerEdge T350

Xeon E-2300 power, from £1,399 exc VAT

from dell.com

Perfect for SMBs and branch offices looking for an affordable and powerful single-socket tower server. Along with support for Xeon E-2300 CPUs and lots of memory, it has a high storage capacity, plenty of expansion space and is sturdily built.

**REVIEW** Issue 335, p98



### Dell EMC PowerEdge R250

With prices starting at around £850 exc VAT for a Pentium Gold CPU, and the option of Xeon E-2300 series chips from £1,461 exc VAT, this is a slim, rack-mounted alternative to the more high-powered T350 that's ideal for SMBs.

**From £845 exc VAT from dell.com**

**REVIEW** Issue 332, p98

### Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here.

**£983 exc VAT from broadberry.co.uk**

**REVIEW** Issue 318, p96



## SECURITY SOFTWARE

### Avast Ultimate

Buy from retail and this is a bargain, with a solid VPN, anti-tracking software and handy detection fees on top of excellent protection. **10 devices, 2yrs, £30 from store.pcpco.co.uk**  
**REVIEW** Issue 355, p84



### G Data Total Protection

G Data provides straightforward, effective and inexpensive protection against malware and other threats to your system, making it a favourite despite its quirks. **5 devices, \$82 from gdatasoftware.co.uk**  
**REVIEW** Issue 355, p87

### Avast One Essential

Avast One Essential has the same malware-detection engine as our top choice, but for free. It even includes 5GB of VPN services per month and a few system optimisation tools. **Free from avast.com**  
**REVIEW** Issue 355, p89

## VPNs

### Surfshark

Reliably fast and goes out of its way to ensure that international streaming services work. Surfshark has a credible track record for privacy, too. **£55 for 27 months from surfshark.com**  
**REVIEW** Issue 360, p87



### NordVPN

One of the best all-purpose consumer VPN services around, and the paid-for version is packed with features – from anti-malware tools to a rather clever mesh file-transfer system. **£94 for 27 months from nordvpn.com**  
**REVIEW** Issue 360, p85

### Proton VPN

A great VPN in its own right, but also the best free VPN service as you get unlimited data. Instead, Proton restricts which endpoints you can access to only three countries: the USA, the Netherlands and Japan. **Free from protonvpn.com**  
**REVIEW** Issue 360, p86

## PASSWORD MANAGERS

### NordPass

This hassle-free option is a great choice for both personal and business use, with a competitive price matched with all the features most people need. **£1.89 per month from nordpass.com**  
**REVIEW** Issue 350, p70



### Bitwarden

Free for individual use and open source, the only important thing Bitwarden lacks is phone support: it works with virtually every device and browser, and the paid option is well worth £10 per year. **Free from bitwarden.com**  
**REVIEW** Issue 350, p71

### Keeper

A great choice for businesses thanks to its focus on security and a zero-knowledge policy, and if you need more options then Keeper has them. **Business edition, from £2 per user per month from keepersecurity.com**  
**REVIEW** Issue 350, p72

## ENDPOINT PROTECTION

### Sophos Intercept X Advanced

Delivers a huge range of endpoint protection measures for the price. It's simple to deploy, device and user policies add flexibility, and seamless integration with the Sophos Central cloud portal makes management simple. **500-999 users, 1 year, £36.50 each exc VAT from enterpriseav.co.uk**  
**REVIEW** Issue 351, p98



## CLOUD BACKUP

### IDrive Business

A top cloud backup choice for SMBs that want to protect on-premises systems and remote workers. Platform and business app support is outstanding, it's easy to use and the simple capacity-based subscriptions are incredibly good value. **5TB, £838 exc VAT per year from idrive.com**  
**REVIEW** Issue 359, p101



## VOIP SERVICES

### 3CX Phone System V20

Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**  
**REVIEW** Issue 357, p98



### WithSecure Elements EPP and EDR

High levels of automation make WithSecure a great choice for SMBs that want endpoint protection on a plate. It's easily managed from the cloud, too. **100-499 devices, £37 each per year exc VAT from withsecure.com**  
**REVIEW** Issue 351, p99

### Acronis Cyber Protect 16 Advanced

Flexible subscriptions keep costs under control, the EDR service stays one step ahead of cybercriminals and it's easy to manage, too. **From £95 exc VAT per year from acronis.com**  
**REVIEW** Issue 359, p98

### TelephoneSystems.Cloud

A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a competitive price. **From £11 exc VAT per user per month from telephonesystems.cloud**  
**REVIEW** Issue 357, p100

## NETWORK MONITORING

### Progress WhatsUp Gold 2023.1

Simple to deploy and offers an impressive range of network-monitoring tools. The choice of licensing plans makes it an affordable option for SMBs, and support teams will love its smart dashboard and NOC views. **Enterprise, 50 devices, £1,192 exc VAT per year from whatsupgold.com**  
**REVIEW** Issue 354, p99



## REMOTE SUPPORT

NEW ENTRY

### NetSupport Manager 14.1

Sets the standard for on-premises hosted support for local and remote workers. It delivers a remarkable range of features and its one-time cost per seat will appeal to businesses concerned about subscription fees. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**  
**REVIEW** Issue 361, p100



NEW ENTRY

### ISL Online Standard

Perfect for SMBs wanting cloud-based support. Features and access security are excellent, as are its flexible licensing plans. **Standard Cloud/One user, £287 exc VAT per year from islonline.com**  
**REVIEW** Issue 361, p99

## SECURITY APPLIANCES

### DrayTek Vigor 2927Lax-5G

SMBs and remote offices that demand always-on internet access will love this affordable security router. It offers an unbeatable set of WAN redundancy features and adds extra value thanks to its built-in Wi-Fi 6 services. **£667 exc VAT from broadbandbuyer.com**  
**REVIEW** Issue 360, p98

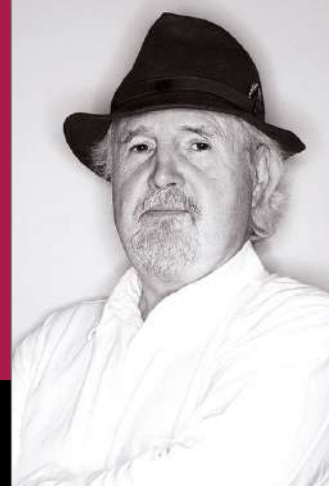


### WatchGuard Firebox M390

Combines strong performance with an incredible range of security measures all at a competitive price. **Appliance with 1yr TSS subscription, £4,273 exc VAT from broadbandbuyer.com**  
**REVIEW** Issue 360, p100



# The dangers of arty-ficial intelligence



Dick Pountain is editorial fellow of *PC Pro*. He only uses ChatGPT as a party trick to horrify arty friends. Email [dick@dickpountain.co.uk](mailto:dick@dickpountain.co.uk)

As AI allows anyone with a keyboard to become a writer or an artist, the world has become a more tedious and more dangerous place

**W**ho would have thought that AI could become so boring so quickly? I feel an urgent obligation to devote a column to its fall from grace, but it appears to be happening faster than I can type. Last month, Nvidia's stock rose faster than a SpaceX test shot before dropping even faster. Now Amazon reports that its Kindle self-publishing platform has been flooded by such a torrent of AI-generated bodice-rippers that it's imposing an upload limit of only *three books a day* on its customers.

Amazon stops short of banning AI-generated content altogether, however, so ChatGPT remains a cancer on the body of the publishing industry in more ways than just crap e-novels. When I review a book, I often look at other people's reviews online, not to plagiarise them but to see other opinions. Recently, though, I've seen spammers using ChatGPT to spatter the net with worthless AI-generated paraphrases and summaries of real books, making it almost impossible to find any proper critiques.

It's not only words. The hand-crafted goods site Etsy recently told the *Atlantic* magazine that it's being swamped with AI-generated T-shirts, mugs and other merchandise that use ChatGPT to optimise Google search rankings and crowd out real producers.

In a previous column I worried about the abuse of AI deep-faked photos to compromise political opponents, but that turns out to have been wide of the mark because it requires a certain political seriousness on the part of the perpetrators. Instead, what's happened is that Midjourney and its ilk are now enablers of pure fantasy and pop-

surrealism. They allow anyone to produce memes and professional-looking posters that make merely spray-painting slogans on a wall feel like something from a previous century.

**W**hen I first tried out Stable Diffusion a year or so ago I was amused by the way its limitations generated such hilariously surreal images, but I'm not laughing now. The recent UK wave of far-right anti-immigrant riots was organised online via Telegram, The-Platform-That-Used-To-Be-Called-Twitter, TikTok and other social media, and an important part of this rallying process is a new genre of surreal nationalistic propaganda memes.

Popular components of such worlds are squadrons of Spitfires, St George Cross flags, knight-crusader figures in medieval armour and British Lions (often wearing T-shirts but no trousers and playing cricket), all as symbols of that old Britain they believe has been stolen from us. AI tools enable them to churn out infinite combinations of these icons in glorious Marvel-comic colour and for minimal effort.

It's worse still in the USA, where these same tools are being used to depict Donald Trump with a six-pack and Hulk-like musculature, occasionally with the golden wings of an archangel and a blazing sword. Visual satire has a long history, from Cruikshank, Rowlandson and Gillray, to George Grosz, Otto Dix and Ralph Steadman, but until now it always required some level of graphical skill, and the purpose is no longer satire but adulation.

It feels as though we're currently in the "phoney war" phase of a battle between states and AI companies over regulation of the internet. The AI side continues to bluster about transforming the world's economy with soon-to-be

**“It feels as though we're currently in the 'phoney war' phase of a battle between states and AI companies over regulation of the internet”**

invented AGI, while also admitting that it will need to use about half of the world's electricity supply to do so (and investing in fusion research).

Ministers were until recently clueless about the threat posed by generative AI tools – the wave of violence in the UK seems to have awakened them – and they're also quite chary about imposing content regulation, over quite legitimate concerns about freedom of speech.

**T**hen we come to the owners of online content – publishers, television and film companies – who form a third force standing on the sidelines watching the impending battle. They're furious that the AI companies have already scraped a sizeable chunk of their properties without payment, but also acutely aware that there might be a profit opportunity here somewhere – who wouldn't like robot authors and actors that you don't need to pay?

We poor authors, artists, actors and other creators can only watch aghast while some members of the general public perhaps see possibilities to gain quick entrance to the so-called creative world without the bother of arduously learning a skill (hence all those Amazon three-a-day novels). How this will all pan out is beyond anyone's ability to predict, even GPT 4.5's. There are too many variables, such as who becomes US president in November, and too many hero/villains such as Trump, Musk and Altman with hidden and volatile agendas.

My guess? The stock market might just call a halt to hostilities, and soon.

[dick@dickpountain.co.uk](mailto:dick@dickpountain.co.uk)

**“ChatGPT is a cancer on the body of the publishing industry in more ways than just crap e-novels”**



# Don't feel guilty about giving kids tech

The whole point of tech for kids is to keep them quiet, so a tantrum-causing bug in an £8-a-month app causes equal anger for this particular parent



Nicole Kobie is PC Pro's Futures editor. If you have parenting tips, please post them to Instagram where she can happily ignore them. X@njkobie

**W**hen I was growing up in Canada, tablets and smartphones didn't exist, so I spent much of the time staring out of the window on our 12-hour drives from Calgary to Vancouver to visit family. To be clear, this isn't a complaint: the views through the mountains and valleys are tremendous, and I have always been very good alone with my thoughts.

Had iPads existed, would my parents have turned to technology to keep my sisters and me entertained? Yes, I imagine so, though annoyingly the cheapos probably would have shared one between the three of us, sparking untold arguments.

Last month, with a toddler of our own on an eight-hour flight, we didn't hesitate: we dug out and charged up our iPad, sought out a few baby-friendly games, and downloaded hours of *Bluey* and *Hey Duggee*. We weren't sure if she'd even understand how to use the darn thing, but we underestimated her capabilities: she got the hang of it instantly, and quietly coloured in digital images, tapped away at a bewildering cooking

**“My ideal app for kids would be calming but engaging. And so carefully designed that any idiot could figure it out”**

game, and wandered around a Hungry Caterpillar app that seems to have taught her introductory phonics. Now I just need to learn them.

Let me be perfectly clear: I feel no guilt at all about this. She was happy. We were happy, staring at our devices or watching films and even managing a bit of sleep. When it was time to put down the tablet to eat or nap herself, she did so with little complaint.

And we don't use the iPad at home to distract her – that's what the TV is

for. But when driving long distances, flying even longer ones, or wanting to eke out a few more minutes at the allotment, I'll hand her my phone.

Now, I get that this is a lot simpler than giving a child their own internet-connected smartphone, and the challenges that come with having a pre-teen online – be they bullying, social media or adult content. The open internet is a scary place. Heck, YouTube Kids can be too much sometimes: the other day we had to turn off an apparently age-appropriate educational video about ants when they started vomiting death at each other.

**B**ut there are challenges to using a tablet with a toddler, such as trying to explain what signal is and why you don't have any. It also takes a fair amount of effort finding apps that are suitable for a child of her age. They need to be appealing to her but also safe – and well enough made that they won't frustrate her. Toddlers are naturally frustrated, we don't need to make it worse, after all.

We've found two apps – a weird drawing, cooking, games combo and the aforementioned caterpillar-themed one – that she will happily play for hours, and might be educational, or at least not actively damaging. Neither is free, of course, costing just shy of £8 a month each. That is not a typo. But what are you going to do, not pay it?

Here's the thing, though: even the most carefully chosen apps are often annoyingly buggy or lack obvious features. Please, for the love of avoiding tantrums, let us download all the features ahead of time, so my kid isn't staring at a loading icon wondering why the button isn't working when she taps it. Or worse, can't access a favourite bit because we lack a signal. The weird cooking game

– you make spooky pizzas, festive cupcakes and colourful smoothies for monsters – has a few odd bugs in which specific decorations or ingredients don't work. And so on.

**A**pps for kids need to be designed with more care, not less, than those for adults – especially if you're going to charge so much. For £8 a month, fix the bugs.

**“When we're driving long distances, flying even longer ones, or want to eke out a few more minutes at the allotment, I'll hand her my phone”**

(I have a similar complaint for Disney: the children's television show *Bluey* reportedly makes up as much as 29% of all streams on the Disney+ network in 2023, yet there's no special way to search the service for the particular video your child wants from the 154-plus episodes available. We pay for Disney+ entirely to watch *Bluey*. Take our money and make some playlists – a selection of all the episodes that feature music or dancing would really make my life easier – or build in tools to turn the show off after a set amount of time. Parents would love fresh ways to watch the show and frankly at this point you owe us.)

My ideal app for my kid would be calming but engaging. Have chirpy music that isn't crucial to what's happening on screen. Avoid flashing fast animations and addictive gaming techniques. Enforce careful quality control to avoid bugs, and make them easy to report. And it would be so carefully designed that any idiot could figure it out – by which I mean the parents, not a two-year-old.

If apps for kids could just step it up a little, I wouldn't mind paying through the nose so much.

[work@nicolekobie.com](https://www.instagram.com/work@nicolekobie.com)

# Streamy dreams of macOS on iPad



Barry Collins is a former editor of *PC Pro*. He's worried he's just given Adobe another idea for wheedling more money out of him. Send donations to [barry@mediabc.co.uk](mailto:barry@mediabc.co.uk) **X** @bazzacollins

**Full-blown app streaming is the only way forward for travelling power users, and I'm not embarrassed to include myself in that category**

**L**ord Honeyball and I found ourselves in a squabble on Twitter/X recently. I was lamenting the fact that Apple won't let us run macOS on the iPad; he was lamenting the fact that I was lamenting that fact.

Why do I want macOS on an iPad? Partly to offset my guilt. I spent a couple of months' worth of mortgage payments on an iPad Pro recently, complete with the Magic Keyboard. It's stupidly powerful, in some ways more so than the M1 MacBook Pro I'm writing this on, but I'm struggling to take advantage of all that horsepower.

I went spendy on the iPad because I wanted it to replace the MacBook on the road. The MacBook is great, but it's heavy, and so is the charger, and it's more than I need for 90% of the stuff I'll do when I'm on a press trip or taking a weekend break. But it's the remaining 10% of jobs – checking pages in InDesign or editing a podcast in Audition – that I find myself lugging the Mac for. The jobs for which there's no adequate iPadOS equivalent.

There are workarounds for this problem. For instance, there's a fantastic app called Jump Desktop that allows you to remotely connect to your Mac (or Windows PC, for that matter) from your iPad. Since the Magic Keyboard has a spacious touchpad and a keyboard that's every bit as good as a MacBook Air's, this effectively lets you turn the iPad into a MacBook.

Yes, of course, it needs a reasonably fast internet connection at both ends, but the emphasis there

is on the word "reasonably". I used Jump Desktop to access my Mac using the busy Starbucks Wi-Fi a couple of weeks ago, and it was fine. (That noise you can hear, by the way, is the sound of Jon combusting at the idea of remote desktopping into your home network over public Wi-Fi. He has a point.)

However, as good as Jump Desktop is, it's not perfect. Although it does an impressive job of minimising lag, there's still a heartbeat of delay. When you're working on something complex, such as a 20-page chapter in InDesign, even that slight pause can be irritating, as you find yourself accidentally resizing text boxes. It's just not the same as working in the app natively on local hardware.

**H**ence my desire to run macOS apps on the iPad. The iPad Pro is more than powerful enough to cope with it, although the limited dollop of unified memory Apple affords the "cheaper" models could be a bottleneck. Still, apps such as UTM proved it was possible to virtualise macOS on the iPad... until Apple decided to withdraw hypervisor support in iPadOS 16.4.

Whenever it's questioned on the coming together of iPad and macOS, Apple goes all church and state. The iPad is for iPadding, the Mac is for Macing. Stop asking us to bring them together, because it ain't happening.

The only solution, then, is proper app streaming. One of the sheer joys of using the iPad Pro is the ability to stream games from services such as Xbox Cloud Gaming or Nvidia GeForce Now. Even over domestic Wi-Fi, there's minimal lag, meaning you can play titles such as *Fortnite* or whatever they call *FIFA* now without any huge hit to performance.

**“When it's questioned on the coming together of iPad and macOS, Apple goes all church and state. The iPad is for iPadding, the Mac is for Macing”**

There's the occasional glitch, but whether I'm playing on my iPad, the Steam Deck or any of the various laptops/consoles we've got lying around at home, streaming games works just fine.

**W**hy can't we do that for apps? If I need to tidy up a few magazine pages or continue working on a podcast edit while I'm killing time in a train station coffee shop, it would be ideal to jump into Adobe's cloud service and stream those apps. This could offer a level of performance that remote desktopping will never match. Largely because my home office is served by a Virgin Media broadband line, not an enormous data centre with terabytes per second of bandwidth to play with.

Most of my work data is stored in Dropbox anyway, so accessing the files I'm working on shouldn't be a problem. And when I have to dash for that train, it can be saved back to the cloud at the end of the session. Hell, it might even tempt me to use and pay for Adobe's own cloud storage if that were a condition of getting access to cloud versions of its apps.

If they can make 3D game streaming feel almost like a console on the iPad, there's no reason why it shouldn't be possible to stream full-fat versions of InDesign or Excel to my iPad. Then I might not feel quite so silly about dropping a couple of grand on a tablet. And I could stop arguing with Jon on social media, too. A win for everyone, surely?

[barry@mediabc.co.uk](mailto:barry@mediabc.co.uk)

**“The MacBook is great, but it's heavy, and so is the charger, and it's more than I need for 90% of the stuff I'll do”**



# DrayTek



## Vigor 2927Lax-5G

The DrayTek Vigor 2927 series Dual-WAN Load Balancing Firewall VPN Routers allow you to make the most of FTTP Fibre Broadband with Gigabit WAN throughput, extensive Firewall, Content Filtering, VPN client/server and Quality of Service controls.

- 5G/LTE Router with Dual Slim Slots
- Ideal VPN Router for SMB
- Dual Gigabit WAN Load Balancer
- Wi-Fi 6 - AX3000 Performance
- 5+1 Gigabit LAN Ports with VLANs
- High Availability
- VigorACS SD-WAN Central Management
- Centralised LAN Management
- Hotspot Web Portal

@DrayTekUK 

draytek.co.uk 

info@draytek.co.uk 



# Readers' comments

Your views and feedback from email and the web

## Google-free phones

On the podcast of Thursday 15 August, Darien made a comment that there are few who would be happy with an Android phone missing Google services (or words to that effect) outside of China.

Well, I'm one of those who is. I have a Galaxy Z Fold5, so Samsung and Google up the yazoo, but I also imported a Moondrop MIAD 01 (which stands for mobile internet audio device) and there are probably few of these outside of China. It's a truly excellent hi-fi phone (double DACs, 3.5mm and 4.4mm jacks), but it has no Google footprint on it.

I've sideloaded apps from other app stores and installed various security apps. What's really noticeable is the amazing battery life (5,000mAh) without all the Google crapware, and how a lower spec phone, with a very basic CPU, can be so responsive too.

It's not my daily driver, and it is a specialist phone with a specific purpose it excels at, but I can't help but think it does all this without the complications of Google in Android.

Oh, and by the way, keep going with the podcast, it's the main one that kept me going at times during the pandemic, and is a highlight of every week! **Nigel Hughes**

## Live long and print

I suppose I can't complain too much about the service given by my printers. I've been using a "second user" HP LaserJet 4050N that I bought refurbished in 2006, which is still working well, and bought a Canon ip3600 for colour printing in 2012.



**BELOW** Printers can last for ages but their ink cartridges won't

## Site unseen?

I wonder how many of these were cast? Hopefully it will amuse those with a good eye.

**Peter B Thomas**



When my trusty ip3600 started showing faults in colour printing I replaced it with a Canon TS705a as I prefer inkjets that use five separate colour cartridges. However, as I still had a good supply of black inks, I decided to continue using the ip3600 for black and white only until the cartridges had been used up. After a few dozen pages I got an ink warning; to my surprise the black cartridge was still almost full – but all the ink in the colour cartridges had been used, even though I was only printing black and white text.

I provide IT support to clients in my local area, and it's a common complaint that colour inkjets of any manufacturer won't print in black and white if a colour cartridge is empty, missing or not recognised. In fact, I presently have three perfectly good printers, including the ip3600 waiting to go to the tip for those reasons.

That doesn't seem to sit well with the "right to repair". **John L Errington**

**Contributing editor Lee Grant replies:** I suspect many *PC Pro* readers have experienced your frustration. Right to Repair is beginning to

address software tricks after years of printers being excluded from legislation. The EU's Ecodesign for Sustainable Products Regulation has specifically investigated "Imaging equipment and consumables" and, although I don't suspect that change is imminent, the environmental consequences of working printers being launched into a crusher for ridiculous reasons has been noted. It's a small step forward, but a step nevertheless.

## Not cleared for take-off

A recent *Futures* article (see issue 360, p126) talks about the use of eVTOLS to replace trains and cars, making journeys between locations via old airfields. I live in a village that is already plagued by jet aircraft from Heathrow and Luton airports. On top of that we regularly have to contend with helicopters flying over our heads at heights of around 1,100 to 1,500 feet. The last thing we need is more buzzing aircraft flying over our homes ruining what little is left of the peace and quiet. There is already little to no regulation of where helicopters can fly and I doubt the situation would be any different for eVTOLS.

I sincerely hope people wake up to the dangers these new technologies are threatening to our quality of life and resist them. **Paul Radford**

## Star letter

### lower case rules ok

Your 30th anniversary issue (congratulations!) coincided with my 70th birthday and inspired me to look back over the 50+ years since I wrote my first program (Fortran IV, 80 column punched cards, one compilation run per 24 hours, overnight) and pick out the most memorable innovations.

Moving from punched cards to keyboard and screen, the first good full-screen text editor (Norton Editor under MS-DOS – I still use it occasionally), the transition from text-based to graphics-based operating systems, the first word processors, and the move from mono to colour screens, have all been really important. But, on reflection, the one change that made the biggest immediate impression was something apparently trivial.

It happened when, some time around 1980, we powered on a new machine (possibly a DEC microVAX) and discovered we could type, for the first time, lower-case letters. Everything had previously been in upper case. We were so impressed we called everyone in to have a look and marvel at this wonderful improvement.

Nothing since then has matched that thrilling moment! **Philip Eley**



This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a *PC Pro* Recommended award. Email [letters@pcpro.co.uk](mailto:letters@pcpro.co.uk)



## Strong Arm tactics

Microsoft's push for Copilot+ PCs is bold and could well pay off, but I don't think it's really about AI: I think it's about the future of Windows. When Microsoft was developing Windows 10X, it wanted to create an OS where everything, from the kernel to drivers, services and software, ran in containered VMs. Sadly it ran like my arthritic dog on lower-end hardware.

Microsoft has told me personally that it will never change anything that breaks any functionality for its biggest customers, and those customers have for decades been reluctant to invest or upgrade their software, and continue to rely on ageing apps and processes.

But could a move to Arm, with 90% software and driver compatibility and success in large enough numbers, finally convince these companies to write new code? This could lead to a future Windows version where some, perhaps even most, of the legacy kernel and OS was no longer required.

That's why I think Microsoft's Copilot+ PCs aren't so much a shift in Windows towards AI as a message to business that it's time to move on. I might be overthinking it, but even if it's not intentional, if it works, we'll all be happy. **Mike Halsey**

## Dead domains

I agree with your recent PC Probe (see issue 360, p12) that it's generally safest to hold on to unused domain names for the few pounds the annual renewal costs, but not always. I have a set of guidelines for valuing domain names that should help.

In brief, valuable names are: short (virtually all names with fewer than four characters have been bought); a single dictionary word (preferably a noun) or a proper noun (someone even bought the 58-letter name of that town in Wales); in a widely recognised top level domain (TLD), such as .co.uk or .com; the name has positive connotations; and it must be relevant, memorable and unambiguous.

Names that meet all those criteria are rare and costly; the price paid for gold.co.uk in 2016 was reportedly £600,000. But if you think names like FredScoggins.com are going to sell, I have disappointing news for you.

Guidelines are not rules. I have obtained a good price for two-word and even hyphenated names. I have also allowed low-value names to lapse and they've not been snapped up by speculators. **Rob Hindle**

# Readers' poll

Out of all these AI features, which – if any – have made you genuinely excited?

37%

Chatty AI features  
such as ChatGPT

12%

Magic eraser/  
image boosts

27%

Other

24%

Text to images  
(or videos)

Maybe we were being too ambitious when we used the word "excited" in this poll. Vaguely interested by? Curious about? Better than watching a TikTok video of cows dancing? "Excited" is perhaps over-stating it," agreed Adam Jackson, "but removing unwanted elements in photos is useful. Mostly the rest of AI seems to be a solution in search of a problem."

"In PC Pro podcast parlance, 'it's a cold from me'," wrote Mark Walsham. "Excited no. Cynical yes. It would seem that the marketing machine is trying to convince us to buy new equipment, with very few (if any) transformational use cases."

Stu Siddons is yet to be convinced: "Until it can be trusted not to put yoghurt in the meat section of my shopping list, it's a novelty item for anything other than making images."

However, there are some positive feelings towards AI. "Currently looking and applying for work and using Copilot to write cover letters has been a great help," wrote Michael Oglesby, we presume without Copilot's assistance. "ChatGPT gets used a lot in my business to overcome 'blank page syndrome', either with code snippets, Excel formulae or web content," said Paul Carter. "In all cases treated as a first draft to be refined and humanised as required."

And we'll leave the last, and positive, word to John Moore. "Individual AI features don't excite, rather it's the myriad potential uses that people have yet to think of. Early dementia diagnosis will beat playing with your photos."

“Magic eraser/image boosting, but only on-device on my S23 Ultra.” @Lycan\_blues

“A laptop that uses AI to tell me my schedule or can sketch something is just meh.”

Mark Walsham

“Despise all this AI stuff. It makes people even lazier IMO.” Daniel Mackey

“I’ve found Copilot works well as a search engine with context.” @67MistakeNot

“Medical advances. Couldn’t care less about any of the above.” Carl Waring

## Join the debate



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# WINDOWS + MAC

## Every new feature

There's a flood of new features coming to Windows 11 and macOS this autumn. **Barry Collins** and **Tim Danton** run you through the changes





It's that time of year when both the major computer operating systems give us a wealth of new features to play with.

For both Windows and Mac this year, there is (to the surprise of absolutely nobody) a focus on AI. However, both will limit the availability of their AI goodies. For Windows, these features are largely limited to the new breed of Copilot+ PCs with built-in NPUs. On Mac, the AI toys are reserved for those with Apple silicon, but even then Apple Intelligence is going to be rolled out gradually and may not arrive in UK English for the launch of macOS Sequoia.

Still, even leaving the AI features aside, there's plenty of new stuff being added to both operating systems. Here's a rundown of the features you should be looking for when the big updates drop.

## Windows 11 24H2

### More compression options

Last year's big Windows update included the option to open 7Z and TAR files natively for the first time. This year, you can compress files in those formats, too.

Right-click on a file or folder in Windows Explorer and you'll see the option to "Compress to...". From the drop-down menu that appears, you can pick from ZIP, 7Z or TAR. The "Additional options" at the foot of that drop-down menu even let you pick the specific compression method and level, for those who need it.

### Sudo arrives

One for the power users to get a small heart flutter from, Sudo has landed in Windows. This basically means you can run elevated commands directly from an unelevated console session, rather than having to right-click, run as administrator and start a new session. Sudo standing for "superuser do", of course.

The easiest way to enable Sudo in Windows 11 is by flicking the switch in Windows 11's Developer settings (easiest found by searching for "developer" in the Settings menu). Here you'll find three options for how Sudo runs: in a new window, with input disabled or inline.

In a new window is pretty self-explanatory and is the default option.

With input disabled means "Windows will run the elevated process in the current window, but the new process will be spawned with its stdin closed," according to Microsoft. "This means that the new process will not accept any user input, so this configuration will not work for processes that require further user input after elevation."

Finally, inline is the configuration you're probably used to from the

**RIGHT** Windows Explorer's context menu has been spruced up – again

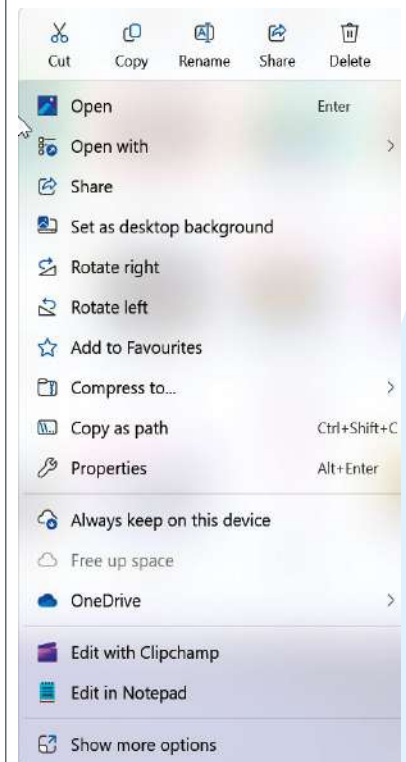
**LEFT** You can now compress files to a number of different formats

Linux world, where Windows runs the elevated process with its stdin, stdout and stderr all connected to the current window. Microsoft warns that this latter option is the most risky in terms of security.

### Spruced up context menu

Microsoft has been fiddling with the design of the Windows Explorer context menu – what appears when you right-click on, for example, a Word doc in your Documents folder – since Windows 11 first dropped. This is hopefully the final lick of paint.

First, everything now gets an icon, rather than the odd-looking, some-do some-don't look of 23H2. Labels have also been added to the icons at the top/bottom of the context menu, so you don't have to guess that the strange-



looking icon with the letter A in it actually means rename file.

### Energy saving for desktops

Microsoft has done good work on energy saving in Windows in recent years, shortening the

ONE FOR THE POWER USERS TO GET A  
SMALL HEART FLUTTER FROM, SUDO  
HAS LANDED IN WINDOWS



# MICROSOFT IS BRINGING THE ENERGY SAVER MODE TO DESKTOP PCs, NOT ONLY LAPTOPS OR TABLETS

default time it takes systems to enter sleep mode, for example.

Now it's bringing the Energy Saver mode to desktop PCs, not only laptops or tablets running on batteries. This means a PC can be switched to always use Energy Saver in Settings, throttling back the amount of processing power and potentially reducing energy consumption.

Although it's unlikely to have much impact in the consumer space, this could be an attractive option for business fleets, especially for relatively undemanding roles such as reception computers, kiosks and so on.

## Scrolling quick settings

File this one under "small but nice", but there's been a subtle change to the behaviour of the Windows quick settings in 24H2. If you click on the three icons to the immediate left of the clock in the bottom-right corner of the screen, up pops the quick settings menu, containing items such as Wi-Fi, Flight mode and Bluetooth.

Previously, you could select which settings went here, but the number was limited to six. Now, the quick settings menu scrolls downwards,

making it easier to quickly access more rarely used settings such as Nearby sharing or Cast window. You'll also now find Live Captions here, where you can have Windows provide subtitles for any spoken-word audio being played through the computer, or even your own speech.

## Wi-Fi 7 support

It might come as a surprise to some, especially those who have splashed out inordinate amounts of money on early Wi-Fi 7 routers, that Windows 11 didn't fully support Wi-Fi 7... until now.

Version 24H2 will be the first to officially support Wi-Fi 7, but of course you'll still need the relevant hardware inside your PC. Official Windows support might prompt more manufacturers to start embedding Wi-Fi 7 radios in their systems, meaning we can finally benefit from features such as Multi-Link Operation (MLO), where devices can connect to multiple Wi-Fi bands simultaneously, theoretically

improving bandwidth and connection stability.

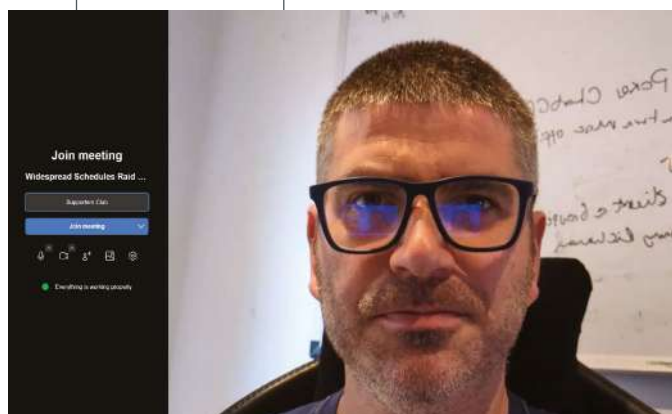
## Use your phone as a webcam

The test Windows laptop we've been using to write this feature is a Huawei MateBook, one of the older models that still had the webcam hidden under one of the function keys, meaning every video meeting gives your poor colleagues the perfect angle to explore the contents of your nostrils.



**ABOVE** Wi-Fi 7 routers are now supported in Windows 11

If you're saddled with such a dodgy webcam, Windows now lets you sub in your Android phone instead. To get this up and running you need to download the Link To Windows app on your phone from the Google Play Store.

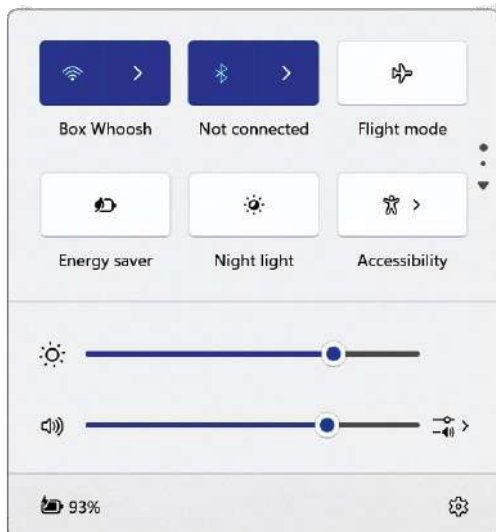


**ABOVE** You can now use your phone camera in video meetings

Once you've got the two devices talking to another, you should find that when you start a video meeting, your phone is now among the list of cameras you're able to select. You might need one of those flexy phone tripods to get the phone's camera in the right place for meetings, mind.

In our tests, this feature only seemed to work when we were joining the meeting via a web browser, not from dedicated apps such as Teams or Zoom, but we were testing a beta release of 24H2, so it may be fixed.

**LEFT** The new quick settings menu can accommodate more than six items



# IF YOU'RE SADDLED WITH A DODGY WEBCAM, WINDOWS NOW LETS YOU SUB IN YOUR ANDROID PHONE INSTEAD



# THAT'S ALL FOLKS... UNLESS YOU'RE USING A COPILOT+ PC

If you thought life wasn't confusing enough, a number of key features that Microsoft has rolled out as part of Windows 11 24H2 will only be available to Copilot+ PCs. Or at least, that's what Microsoft is saying now. It has form when it comes to changing its mind about such things, quietly adding features to Windows 10 that were once thought unique to Windows 11.

There is some sense to this bifurcation of Windows, however, as all the features below use the neural processing unit (NPU) built into a handful of recent processors. And even if you bought a laptop with Intel's Core Ultra

inside, or AMD chips with first or second generation Ryzen AI inside, you're out of luck: while those processors include NPUs, they aren't powerful enough. Microsoft has set a tough threshold of 40 TOPS – tera operations per second – and at this time only the Qualcomm Snapdragon X chips and AMD Ryzen AI 300 series qualify. Intel's "Lunar Lake" family, due later this year, are passed for Copilot+ PC duty, too.

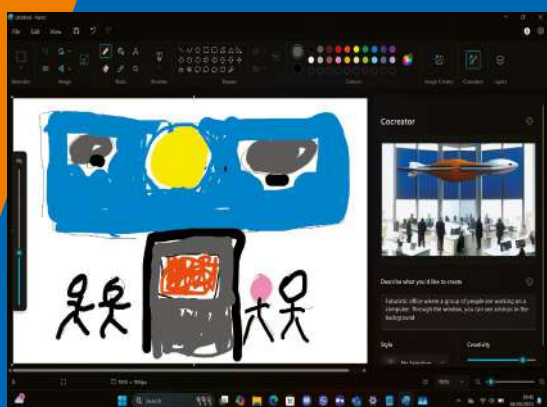
So here are the new features that will – probably – only be available with Copilot+ PCs.



## Windows Studio Effects

All videoconferencing apps allow you to blur backgrounds and add annoying virtual backdrops, but that consumes a fair amount of power from your CPU or GPU. It's one of those tasks that NPUs are born for, and they consume significantly less wattage, leading to better battery life. It was one of the most touted features when AMD introduced Ryzen AI into its flagship mobile processors 18 months ago.

With this update, Windows can use AI to add background blur, bokeh effects, eye correction and fancy creative filters to your video feed. That means it doesn't matter whether you use Zoom, Teams or Google, the effects will work. We like the blurring but can frankly live without everything else.



## Cocreator

Unlike Image Creator, Cocreator (also built into Paint) needs local AI to work. We've now tried it a few times, and have come away thinking... well, not very much. The demos look great, as Cocreator turns a dreadful sketch of a boat with stick drawings of trees into a realistic seascape (helped along by a descriptive phrase), but in reality we suspect most people will play with this once and then forget about it forever.

The only exception might be children – namely the prime drawers of objects – but even then they'll need a laptop with a touchscreen to take advantage. Or a graphics tablet. But using a mouse or touchpad to try to draw never ends well.



## Image Creator

Still in Preview, Image Creator incorporates AI-assisted image creation into Paint. Click on Image Creator, type your text prompt and let Paint do the rest. For example, in the image you see here we asked it to create a "Laptop computer built from British pound notes". And it does an okay job.

We can't see why this shouldn't come to all Windows 11 PCs, as it uses DALL-E in exactly the same way that Copilot Designer does.



## Live captions

Falling into the category of "it works well if everyone speaks clearly and finishes their sentences without slipping into colloquialisms", this is certainly a better translation aid than relying on your school-learned French. It also covers over 40 languages (and will automatically recognise them).

Microsoft's implementation is simple by default, appearing as a strip at the top of the screen (you can position it wherever you like), but you have a choice of colours – for example, yellow on blue for extra clarity.

## Windows Recall

Question marks the size of Olympus hang over Windows Recall, once the headline feature for Microsoft's Copilot+ PCs. The idea: that Windows would continually take snapshots of users' screens, use OCR to turn that into searchable info, and then allow users to search back through time to find docs, photos or whatever they were working on.

Despite Microsoft's assurances that this is a "100% privacy focused" feature, that all data is stored locally, and that you can switch it off, we still don't know when Recall will see the light of day.



# macOS Sequoia

## Apple Intelligence (sort of)

The arrival of AI was very much the focus of Apple's big Sequoia reveal, but it seems likely that Apple will tread very carefully when it comes to bringing Apple Intelligence to the Mac.

At the time of writing, none of the Apple Intelligence features has been added to the public beta of macOS 18, which is now at its third iteration. Apple promises they will come later in the testing cycle, but only in "US English". Other languages and the full spectrum of announced features are unlikely to be ready for day one. Perhaps worried about the negative press of AI spitting out nonsense, Apple is seemingly taking it steady.

So what is promised? Well, a lot of what we've already been using from other AI companies over the past couple of years. Apple Intelligence will write emails for you, summarise long documents, second-guess your replies to messages. Then there's "Genmoji", the ability to create generative images to send as emoji, which will either delight you or send you running for the sick bucket, probably depending on your age.

Where Apple Intelligence gets most interesting is when it starts to get its eyes on your data. For example, notifications can be

prioritised, with the AI deciding what's important and what's not worth interrupting your flow. Similar prioritisation can be applied with your Mail inbox, with Apple Intelligence automatically floating items such as boarding passes to the top of the inbox when you're preparing to board a flight.

Siri, the largely ignored voice assistant when it comes to the Mac, is also going to become much sharper, says Apple. Ask Siri to "show me the files Tim sent me last week" and it should be able to dig through your files until it finds the relevant information. This is the sort of deep-level OS integration that Microsoft promised with Copilot a year or so ago, but has yet to deliver. It will smart if Apple gets there first, although this seems like the harder-to-crack stuff that may well not make the initial release this autumn.

Apple Intelligence is also drawing a line in the sand. It will only be available on Macs running Apple silicon, further cutting adrift the Intel-based systems. That said, machines as far back as the 2017 iMac Pro will get Sequoia, even if the AI baubles are withheld.



**ABOVE** iPhone users can now mirror the phone screen on their Mac

## iPhone mirroring

As Windows continues to hug Android handsets ever tighter (see p28), Apple is tightening the already body-hugging bonds between Mac and iPhone.

Continuity will allow iPhone owners to mirror their handset on the Mac screen. Apple is clearly applying some of its learnings from mouse control of the iPad here as, of course, Mac displays aren't touchscreen. But if the iPad experience is anything to go by, it shouldn't prove too problematic to control iPhone apps with mouse/touchpad and keyboard. For example, you click the bottom bar to get back to your homescreen, and there are menu options for opening the app switcher or Spotlight.

Audio will play through your Mac, too. So if you want to watch an Instagram video on your Mac, for instance, it will play through the Mac's speakers/headphones. The iPhone's camera or mic won't be accessible to the Mac, however.

With mirroring activated, phone notifications are displayed in the Mac's regular Notification Centre, meaning you shouldn't miss any important texts or WhatsApp messages. Mirroring is all handled wirelessly, and the iPhone can be charged while mirroring.

It's available to old Intel Macs, too, as long as it has a T2 security chip.

**BELOW** Apple Intelligence will only be available on Macs running Apple silicon

## WHAT IS PROMISED? WELL, A LOT OF WHAT WE'VE ALREADY BEEN USING FROM OTHER AI COMPANIES



## Snap windows... sorry, window tiling

Twitter (or whatever it's called this week) lit up like a Christmas tree when this one was announced at the Apple keynote, with every Microsoft fan gleefully pointing out that this had been built into Windows since the time of Oliver Cromwell.

Nevertheless, macOS Sequoia will now let you



# NOTES NOT ONLY ALLOWS YOU TO RECORD AUDIO WITHIN NOTES, IT GENERATES LIVE TRANSCRIPTS OF WHAT'S BEING SAID

drag windows to the extremities of the screen to snap them into place, making it easier to tile your apps. A new set of keyboard shortcuts will achieve the same effect, if you can be bothered to learn them.

It's worth pointing out that several Mac utilities, such as Magnet and Raycast, already let you do this, so it's not exactly the emergence from the cave that the gleeful Windows fanboys might think it is...

incurred on a trip and you want to pick out how much the meals and petrol cost because you're splitting the bill with others. Type "meals + petrol =" and Notes should tot up the damage (provided they're listed in the note above).

It's not quite as impressive as the sketched mathematical functions that are being added to the iPad, but it's something.

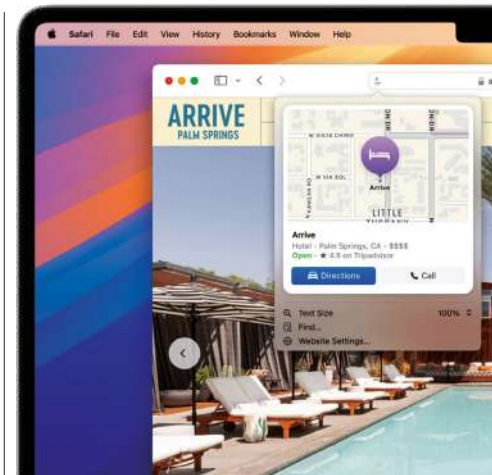
## Safari touch-ups

The Safari web browser is getting a few new features with Sequoia. The Highlights feature has the potential to be great or fiercely annoying. Say you're checking the website of a restaurant you're about to visit, Safari will display a Highlights pop-up that gives you directions on how to get there. If you're reading a review of a new album, a Highlight can take you to said album in Apple Music. The

jury's out on this one until we get to try it in (most likely) anger.

Other new additions are an AI-injected Reader mode that provides a high-level summary and table of contents for long

**RIGHT** Safari's Highlights feature can give directions from a website



**LEFT** Sequoia lets you drag windows to the edge of the screen to snap them into place



## Fake video backgrounds

Even if your video app of choice doesn't allow you to disguise your piles of washing or ramshackle home office behind a fake background of the Serengeti at dawn, macOS will now do so for you. You can hide the background with a selection of Apple's always immaculately shot wallpaper landscapes or one of your own photos, helping to disguise the domestic carnage when you're having a job interview.

## Clever Notes

Again, more AI fluffiness, but these new additions to the built-in Notes apps are worthy of, well, note.

First, Notes now not only allows you to record audio within notes, but it generates live transcripts of what's being said. This feature is going to be limited to English-speaking regions for the time being, and it's not clear if there's going to be a time limit on the amount of audio you can record and transcribe, but it could prove to be a very valuable feature if the transcripts are accurate enough.

Notes is also going to let you perform basic maths functions. So, say you're totting up the expenses

articles, which Apple already conveniently (except for publishers) strips the ads from.

Web videos can also pop out of their window now, letting you keep an eye on a breaking news event while cracking on with other work, for example.

## Avoid presentation blunders

It's ridiculously easy to share the wrong screen or leave a confidential window open when presenting over a video link. Presenter view aims to eradicate those mishaps.

In the top-right corner of the screen, the presenter view will show exactly which windows you're sharing with the world before you broadcast them, and allow you to quickly close any that you've accidentally displayed to colleagues or clients. On the flip side, video meeting presentations are now set to be even duller. ●

**BELOW** Presenter view aims to prevent mishaps in presentations





# CYBERSPACE ODDITY

## The story of BowieNet

In the 1990s it wasn't only AOL and CompuServe offering internet access, but rock stars, too. **Lee Grant** recalls the extraordinary story of David Bowie's ISP





**T**he mid-90s was a race to get the world online. Every month, magazines such as *PC Pro* carried CDs from faceless ISPs

desperate to bag sign-ups, but there was one ISP that was radically different from the rest, spearheaded by a man who was used to shifting millions of CDs of his own.

David Bowie didn't just lend his name to an ISP; it wasn't some half-arsed piece of merchandise. He regularly joined chats with members, and delivered internet innovations that were well ahead of their time, such as the live streaming of concerts and offering 3D environments for fans to mix in. All this long before YouTube or *Second Life* were even a thing.

We've spoken first-hand to the people who worked with Bowie to bring "cyberspace" to the masses. We'll also hear from fans who gorged on unprecedented access to their hero.

If you've never thought of David Bowie as an internet pioneer, then we're about to change your mind. This is the story of BowieNet.

## Sound and vision

Ron Roy had always been a music fan. "I had a Ziggy Stardust poster over my bed," he said. "I was a massive Bowie fan. My cousins were members of the Monkees and the Beatles fan clubs. They would get stuff in the mail like a newsletter and would lose their minds."

**ABOVE David Bowie was an online innovator as well as a musical one**

Roy and his business partner Bob Goodale forged successful careers in the entertainment industry and by the 1990s, believed "the net" could be the perfect medium to refresh the fan club model, but they needed a focus. "Bob knew Bill Zysblat [Bowie's manager], so we decided to begin with David."

Roy and Goodale secured a meeting with Zysblat and Bowie. "We still didn't have all the dots connected, but we pitched for about three hours," said Roy. Bowie loved the idea and concept. "We said we had to raise over a million dollars to get it going, to bring engineers and graphic designers in. Four or five days later, Zysblat called. 'David wants in on the concept of the online fan club and he wants to be your first investor.'"

With Bowie's backing, Roy and Goodale formed the technical partnership management company UltraStar, with a strategy to bring entertainment, sports and fashion clients to their "fan-club on the web" model. "We said, 'let's get this model, the technology, perfectly right. Let's hyper focus on BowieNet, then bring more artists and bands to our platform and grow the company.'"

**David Bowie didn't just lend his name to an ISP; he delivered internet innovations that were well ahead of their time**

BowieNet was conceived as Bill Clinton's Telecommunications Act of 1996 became law. This marked a pivotal transition shift between the telephone and internet ages, and broke the monopoly of large telecommunication firms (such as AT&T) by distinguishing between telephony and data, allowing smaller companies to compete in building the "information superhighway". Roy acknowledges this stroke of good fortune. "It allowed a white label model, any brand at that point could layer on the ISP," he said. "Our timing was very lucky."

The ISP chosen to power BowieNet was Concentric Network Corporation (now Verizon), but the in-house developers were skilled graduates from Carnegie Mellon and MIT. However, it was Bowie himself driving the innovation. "We didn't want to overwhelm him with approving photos, graphics and navigation buttons, but he wanted to see everything," said Roy. "David was a really good business partner and a great collaborator."

## UltraStarman

BowieNet launched in the USA on 1 September 1998, and was the showcase for UltraStar's Affinity ISP. The concept was to give fans a direct gateway to their heroes. Nobody understood the importance of that exclusive access better than Bowie. He wasn't just putting his name to the product; he was the product.

A monthly fee of \$5.95 gave fans access to BowieNet, a subscription-only web service, but for \$19.95 a month BowieNet also provided a dial-up internet service, complete with [davidbowie.com](http://davidbowie.com) email addresses and webspace to host Bowie fan sites. Irrespective of how fans accessed BowieNet, it offered a space for the like-minded to meet and socialise, years before MySpace, Friends Reunited or Bebo were launched.

Charlie Brookes discovered Bowie in the 80s, seeing him in concert almost 200 times. He was one of the first fans to join BowieNet. "I didn't hesitate," she said. "It had David Bowie attached to it, so I was interested."

One BowieNet innovation that hooked Brookes was BowieWorld, a 3D environment for fans to meet which predated *Second Life* by half a decade. "There were 12 rooms and you became a 3D avatar, not just a name on a screen," she recalls. "It was a



proper interactive thing. You could go in and dance with your mates. I used BowieWorld to chat with my mates in America and all over Europe.”

BowieWorld was developed by Worlds and, because of the immense hardware requirements to run the application software, it ran on their hardware, not UltraStar’s. “Thank God,” laughs Ron Roy. “That was way beyond our technical scope, but David created his own avatar to be in there.”

Another innovation of BowieWorld was gamification. “Initially you were a penguin and it took months of interaction to build your character, then you became a human and could choose clothes and stuff like that,” said Brookes.

Brookes’ penguin avatar became one of the many subjects of conversation when she was picked to chat with David Bowie on a Talk Radio/BowieNet “simulcast” in January 1999. Bowie said: “Charlie, I know exactly why you like it so much. I really love going in the chat room, so I go in both as myself and anonymously.” It’s an open secret that Bowie’s username was Sailor, but he confessed to Brookes about an alternative sobriquet. “I’ve been frequently in as Mr Plod. When you go in as David Bowie, they don’t believe it’s you.”

BowieNet member Steph Lynch was wowed by Bowie’s keenness to engage. “He was incredibly curious and liked to share his knowledge and passion,” she said. “He genuinely was interested in people and what they found interesting and exciting. You could have conversations, debates, discussions and also be incredibly silly.”

Lynch devised a technical solution to notify her whenever Bowie appeared on BowieNet. “I’d leave my computer running and every 57 minutes it would disconnect from the internet and redial, so I learned to go to sleep with my modem making noises. It was configured so that when Sailor appeared, a loud noise would play.” This was, of course, in the dial-up days when every minute spent online was added to your phone bill.

Still, the heinous expense of maintaining a round-the-clock internet connection paid off when Lynch first met Bowie. “He knew who I was,” she said. After a London TV appearance, Lynch had met up with other BowieNet fans. “I made a crap website with photographs from that evening and he must have gone through them because it’s the only way he would have been able to put my name to my face.”

Remember, in the 1990s, Lynch couldn’t post phone pics to Instagram. She had to get the film developed, scan the images, create thumbnails

then throw everything together with HTML. “I didn’t do it for him,” she said. “I did it because everyone wanted copies. People had come from all over the place to see David. That sense of community added an extra dimension.”

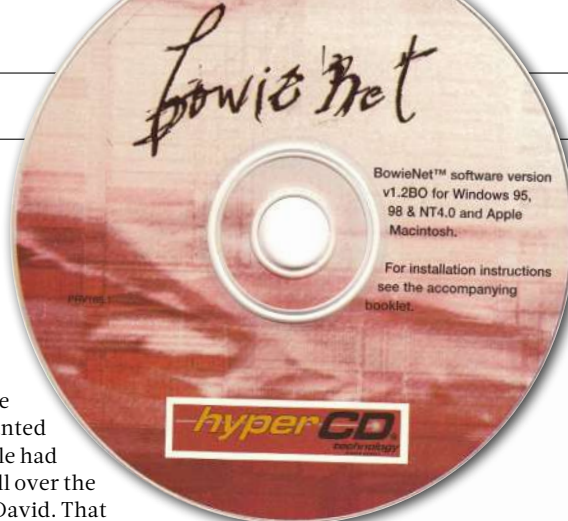
## Stream like a baby

BowieNet succeeded in connecting Bowie with his fans, but his music always took centre stage. Although BowieNet Radio played curated tracks a decade before Spotify appeared, it was the streaming of performances that were the real fan highlight. In the 90s, it was technologically risky, as Roy explains. “David was up for something that may not [have worked] because a 56k modem was so limited. We tried every compression algorithm people would bring to us. We could record and compress concerts, then put up snippets, but when we did live streams, we’re always sitting there saying, ‘please technology gods, be nice to us’.”

That pressure was also felt on stage. Mark Plati is a musician and songwriter, co-producing two Bowie albums (*Earthling* and *Heathen*) from the BowieNet era. “The first cybercast was 30 September 1997,” he said. “We went to Boston and did a show. I had to sit at a little desk with headphones and mix it, basically like it was going out on the radio, except that there was no radio, it was going out on the web live. That was not only the first time I’d ever done it, but the first time I’d ever considered it was a possibility.”

Plati played on and produced Bowie’s 1996 track “Telling Lies”, which is considered the first downloadable single by a major artist. He also played on “What’s Really Happening?”, a track where writing the lyrics was a BowieNet competition prize. Plati understands why Bowie threw himself into BowieNet. “I wasn’t surprised because he would put that energy in everything,” he said. “He’d go 200%, not a shock at all. And it was cool.”

Bowie was keen to share his passion for the internet with other members of his band. Singer, songwriter and musician Emm Gryner



**ABOVE** BowieNet even produced its own CDs to help fans get online

appears on several of Bowie’s live albums. “I had a website of my own and I remember him giving advice on how to do it. ‘You’ve got to click through like you’re the fan and experience it’. I remember him being really excited about the opportunities and connectivity that it brought.” Gryner also recalls seeing the BowieNet fans from the stage. “You could see the neon green shirts of BowieNet members, show after show. It was a reminder that innovation was happening behind the scenes. I think David took pleasure in showing what could be done. The end of it always was about how can we connect, not how to make a zillion dollars.”

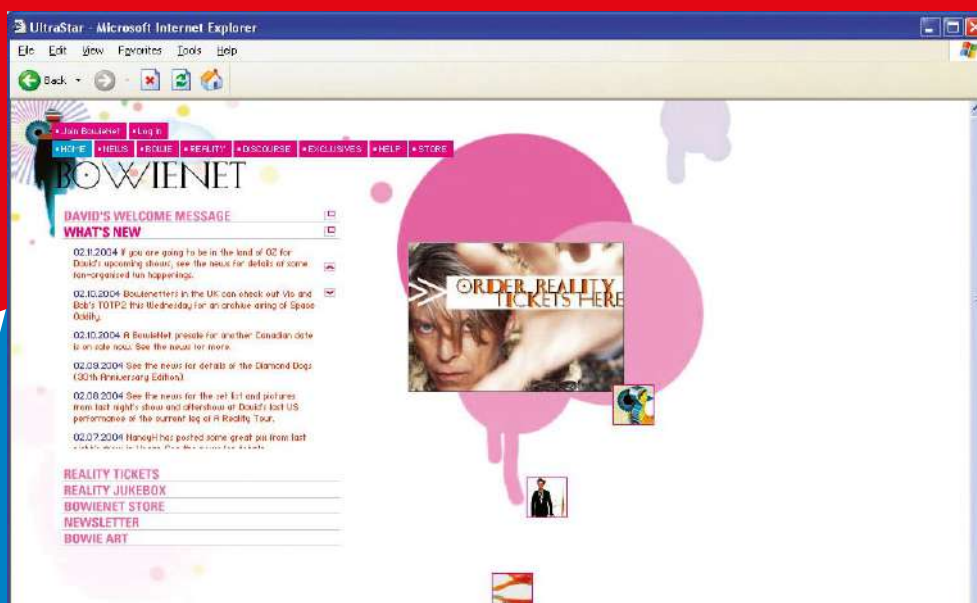
**David took pleasure in showing what could be done. The end of it always was about how can we connect, not how to make a zillion dollars**





**ABOVE** BowieWorld was a 3D environment that predated *Second Life* by years

**RIGHT** BowieNet subscribers were given priority ticket access for gigs



**BELOW** 3D avatars were another innovation in BowieWorld



Gryner, Plati and Bowie shared a stage many times. In 2000, they performed to 250,000 people at Glastonbury and again, two days later, at the BBC Theatre in London for only 250 invited BowieNet fans. Gryner remembers that the performances for BowieNet fans felt different. "I remember being at the BBC Theatre playing "Heroes" and David saying that it felt too big for the venue. I don't know if that speaks to anything about the BowieNet community being so small, but they were so into it. That was something that stood out to me about how he felt about that show."

Mark Plati also noticed David's connection with BowieNet members. "He was so committed. We did Wembley [NetAid, 9 October 1999] and then went to Ireland for 200 people. I'm sure they viewed it as cutting edge, having BowieNet as this way to connect, but his fans had already found a way to do that. This just made it super-efficient."

### Ch-ch-ch-changes

By the new millennium, BowieNet was running in the USA, UK and Europe. "You had to figure out the billing, exchange rates," laughs Roy. "We had customer service, where it's 3.13 here and 8.13 there, so lot of emails and lots of taking care of people."

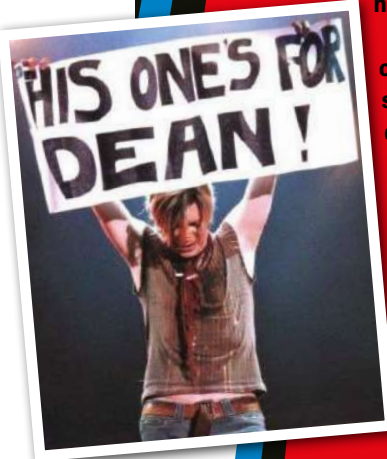
With broadband set to increase the operational complexity, UltraStar got out of the ISP business, ushering

BowieNet and to cinemas around the globe in 5.1 surround sound.

Sadly, however, it all came to a rather abrupt end. The Reality Tour halted in June 2004 when David Bowie suffered a heart attack during a show. Save for one or two appearances, Bowie all but vanished from public life. The fuel for BowieNet was gone. "It was a ten-year journey," said Roy proudly. "David was stepping away, he had some health issues and was really focused on raising his daughter. The partners got together and said it was time to wind this down."

UltraStar was sold to Live Nation and BowieNet became a free-to-all website. Without the affinity hub, the fans scattered. "It's just the way the internet went," said Charlie Brookes. "Everything changed with social media. You don't need to go [to BowieNet] because it's all over Facebook and, of course, he wasn't there to drive the car."

Yet, even though the BowieNet hub was long since dissolved, a community remains. "We still get together and it's as though nothing has changed," said Lynch. "A few years ago we met and it was like a mini BowieNet reunion."



## Bowie's chats with fans

BowieNet wasn't merely a fan site with devotees talking among themselves; it was a bilateral community. "It wasn't just the fans chatting, it was us chatting with David and David chatting with us," said member Steph Lynch. "There were official chats that happened but he would pop in whenever he fancied. He came in because he wanted to."

Bowie also reached into the community at times of sadness. When BowieNet member Dean Andrews was killed on the way to a concert, Bowie posted: "We have just heard about the tragic death of Dean Andrews.

The band and I send sincere condolences to his family and loved ones. Sailor."

Charlie Brookes, one of Dean's closest friends, created a banner saying, "This one's for Dean". A few days later, Bowie held it up at his Glasgow concert for the audience to share.

When Bowie entered the chat it was chaos, but as the following transcription shows, he was adept at sharing information while keeping multiple threads alive and delivering the acerbic wit for which he was known.

**mugwump says:**

Hey db, In your travels around Indonesia, ever come across an African gentleman who is some sort of prophet?

**Host "David Bowie" says:**

Okay mugwump, you've asked this question about a million times. What's the punchline? It better be good. I'll watch out for it.

**"Total Blam Blam," says:**

That is cool.

**Host "David Bowie" says:**

I couldn't agree more. Whatever it is you're talking about.

**Picadilly says:**

In the movie *Labyrinth*, were you wearing any knickers?

**Host "David Bowie" says:**

Picadilly, I'll have you know they weren't just any knickers. Jim Henson had to dig deeply into his wallet to get me those particular pair of knickers. They were hand-woven from the wings of a rare Dulwich butterfly that only flies by night. So my knickers were, in fact, made up of over 2,000 flies. Which made going to the toilet very easy.

## There were no trolls on BowieNet. It was a community that you wanted to belong to and you had to pay to be part of

users to the \$5.95 (or equivalent) subscription for BowieNet. It was a good move. "Very few customers left the platform," said Roy. "We were pleasantly surprised, it showed the strength of the affinity."

Seeing what BowieNet had achieved compelled other major music acts to sign up to UltraStar's offering, but Steph Lynch believes that there's a reason we're not talking about HansonNet or RedHotChilliPeppersNet. "It wasn't a bunch of media managers making decisions. David was the driving force behind it."

For what would become Bowie's final tour (A Reality Tour), BowieNet subscribers enjoyed videos of rehearsals, invites to BowieNet-only gigs, tour bus footage and priority ticket access. Bowie and UltraStar also continued to push technological boundaries. A performance from London's Riverside Studios in September 2003 was broadcast on

Plati suggests BowieNet provided an environment that's hard to replicate on social media. "There were no trolls on BowieNet. It was a community that you wanted to belong to and you had to pay to be part of. Facebook is free and you get all kinds of whatever on there. I wouldn't find that very exciting."

Having become great friends with Bowie, Emm Gryner wonders how he would have felt about social media. "There was something about that insider community that changed with social media. If I'm going to put something out on socials, the whole world can comment. That doesn't seem to me like something that would have particularly excited him."

No, what excited Bowie wasn't only the pioneering live streams, the 3D environments or unique downloadables, but the opportunity to interact in a shared safe space with his most loyal fans. As Ron Roy put it: "The connectivity was great, the affinity was greater." ●





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# INSTANT EXPERT

# CANVA

**Nik Rawlinson** explains how to master the hugely popular graphic design tool that does everything from editing images to designing T-shirts – and it needn't cost you a penny

**I**f you've any interest in graphics, you've probably heard of Canva. It's the fastest-growing visual design tool on the market, expanding from a million users ten years ago to an estimated 170 million at the end of 2023. Much of its appeal is down to its powerful image-editing and generation tools; these have a wide range of applications, but are particularly suited to commercial marketing and merchandising.

It also doesn't hurt that you can use Canva's core features for free, and run the application entirely in a browser – although there are also native apps for Windows, macOS, iOS and Android.

There are also some powerful integrations. Since Canva's launch in 2013, its parent company has absorbed the Pixabay stock photography, footage and music site, and the Pexels stock photography and video site. Most recently, Canva acquired UK software developer Serif, which produces the Affinity line of professional photo editing, vector graphics and page layout software – suggesting scope for exciting future expansions.

## Canva by numbers

Launched 2013

Countries served 190

Monthly active users 185 million

Latest product update May 2024

Platforms Windows, macOS, Android, iOS, web

## What does it cost?

Individuals can sign up for Canva for free. Every user gets 5GB of cloud storage, plus access to more than two million templates for social posts, flyers and more.

Upgrade to Canva Pro for £100 a year and you get almost double the number of templates, along with nearly 40 times as many bundled fonts, graphics, photos and video assets – plus the ability to export print-ready designs in CMYK.

Pro users also get much more liberal usage allowances for AI-powered features: for example, free users have a lifetime limit of 50 uses for Canva's smart text and image generation, while Pro subscribers can use each one up to 500 times a month. Other Pro features include AI-powered erase, animation and morphing tools, plus Magic Eraser, Magic Expand (to extend images beyond the frame) and audio enhancement for voice recordings.

For business users there's also a Team plan (costing £90 per user per

year with a minimum of three seats), plus an Enterprise tier for larger organisations. These plans offer similar tools and features to the Pro subscription, but add extra administrative capabilities. Enterprise users also get API access for custom integrations.

## How do I get started?

New Canva users can sign up at **canva.com** and try the Pro tier for free for the first 30 days. Be aware: you'll need to provide your card or PayPal details when you enrol, and if you keep using the service after the trial period it will automatically convert to a paid plan. However, Canva will warn you a week before the trial ends, so you can cancel if you'd rather not pay for an ongoing Pro subscription.

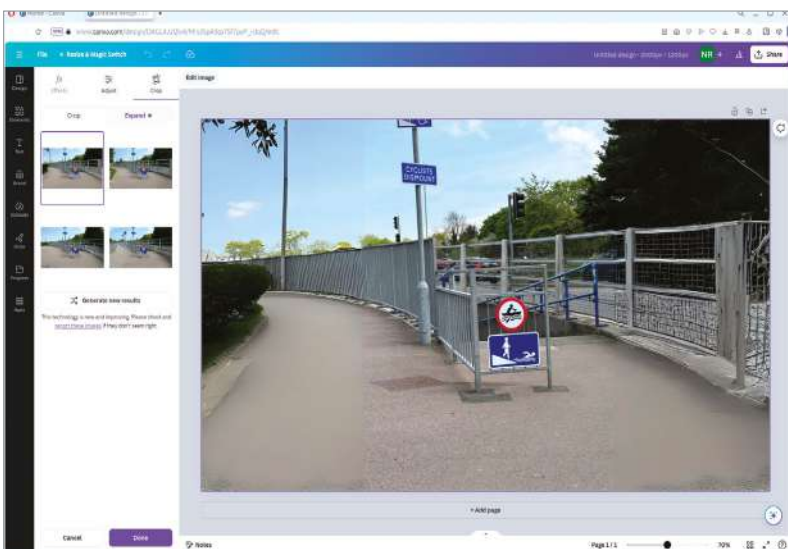
## Top five features

Canva is packed with tools for editing video, creating social media posts and even designing mugs and T-shirts. These are our top five – and how to get started with each of them.

**RIGHT** It's easy to change the background of images in Canva







# YOU CAN RUN THE APPLICATION ENTIRELY IN A BROWSER



## 1 Quickly remove backgrounds

Image backgrounds can be distracting, but it's often tricky to edit them out of your photos. Canva's smart background remover automates the process of isolating your subject, with manual tools for tweaking any less-than-perfect results. This feature is part of Canva's AI-powered "Magic Studio", which requires a paid subscription, although it can be used as part of a 30-day trial.

To use it, point your browser at [tinyurl.com/36icanva](https://tinyurl.com/36icanva) and either drag your image onto the "Online Background Remover" block at the top of the page, or click "Upload your image" and select it in the usual manner. Now click BG Remover in the sidebar and Canva will automatically detect and remove the background from your image.

We found that Canva did a great job with our test images – even cat

portraits, with loose strands of hair in the foreground and fuzzy detail in the face. The only problem was that it worked so well that it also removed the blanket the cat was lying on, leaving the animal hovering uncomfortably in space.

To fix this, click the BG Remover button again to reveal the Erase and Restore brushes. Click Restore, select a brush size, and paint over the area you want to return to the image. If you're having trouble working out how far to go, click the "Show original image" switch to reveal a translucent underlay of the original picture.

## 2 Extend images

Sometimes, an image isn't big enough to fill the intended space – and you can't blow it up without cropping out content around the edges. Canva can help by using AI to imagine what might lay beyond the edge of your photo,

**TOP/ABOVE LEFT**  
Canva took our portrait image and created the surroundings to fill a landscape frame

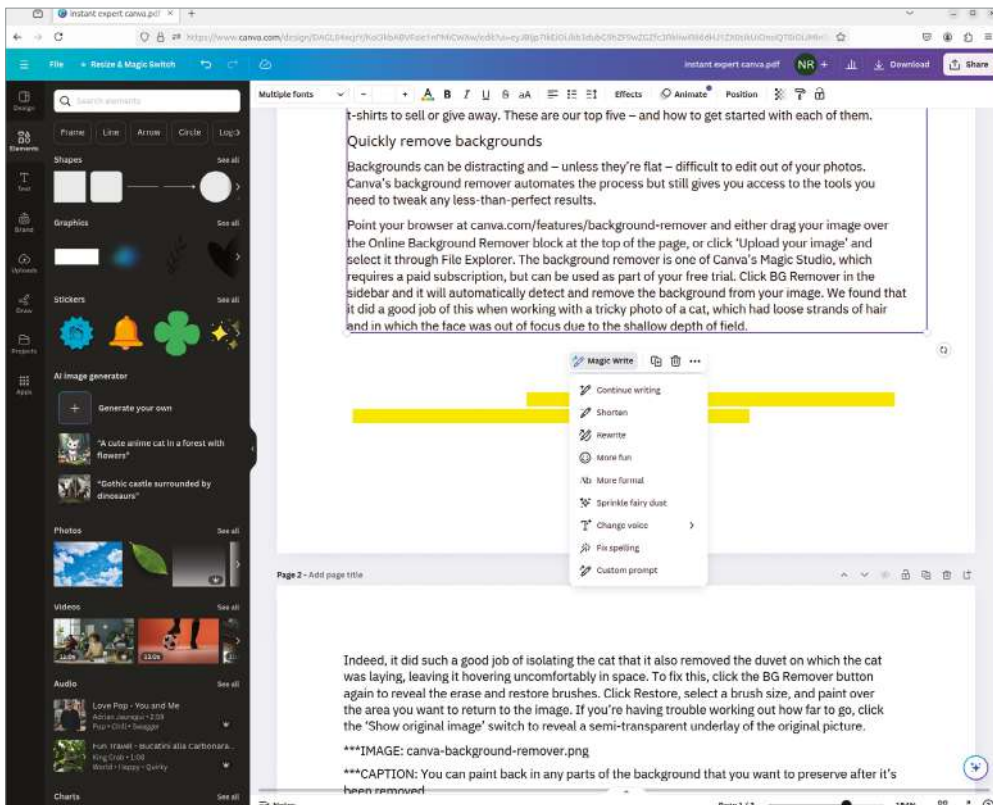
**ABOVE** Canva can also write flowing text in response to your prompts

and then generating the "missing" parts to fill the available space.

To get started, return to the Canva homescreen, then click "Create a design" at the top of the page. Select Custom Size at the bottom of the menu and enter the dimensions you want for your final image. Don't forget to select a unit (the default is pixels, but if you're designing for print you probably want to switch to millimetres or centimetres).

Now add your photo to the document by clicking File, followed by Import Files, then Choose Files. Select the photo you want to expand and it will be imported and shown in your asset library; drag the photo from the library to your document.

Now click the Edit Image button immediately above your canvas, followed by the Magic Expand button in the Magic Studio sidebar that appears. Make sure Expand is selected on the following page, then choose



Whole Page to extend the image to fill your document. Alternatively, you can select 1:1 to create a square image or pick Freeform and drag the handles at the corners of the image to define a custom size. When you've made your selection, click Magic Expand to fill the desired area. We found the results were good but not always perfect; realising that AI doesn't always hit the mark first time, Canva automatically creates four options, from which you can pick the best one.

### 3 Write - without writing

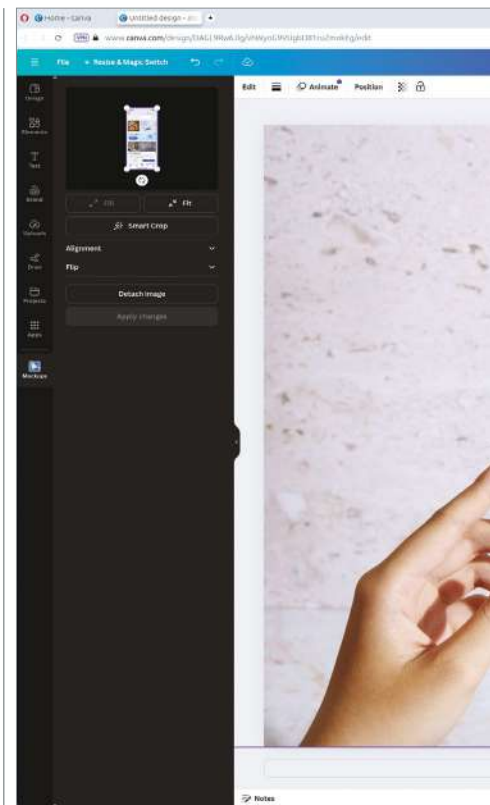
Designers will be familiar with the faux Latin text "Lorem ipsum dolor sit amet...", which is traditionally used to fill out text boxes when the final copy hasn't yet been provided. Canva offers a better AI-powered solution, dubbed "Magic Write". This

can generate natural flowing English prose in response to your prompts – or continue writing a piece when you've run out of steam, or rewrite existing text if it's not up to scratch.

Magic Write content can be dropped straight into traditional designs like flyers and presentations, or you can edit and finesse it in Canva's word-processor view. To access this, go to the Canva home screen and click "Create a design" followed by Doc. Hover over the default placeholder text that appears in grey and click the "+" button; now select Magic Write from the menu, followed by "Try it out". You can now write your prompt and click Generate; for example, we asked it to "write a short job advertisement for a designer who has excellent Canva skills and the passion to take our business further". It delivered what you see in the image

**ABOVE** You can rewrite text in PDFs – or ask Canva to do it for you

**ABOVE RIGHT** Canva takes the pain out of making promotional mockups



on p39, with bracketed sections where we need to fill in the specifics.

If you like what it produces, click Insert to add it to your document. If you don't, click the circular arrow and it will try again.

## 4 Edit PDFs

Everyone needs to edit a PDF sooner or later. Sometimes you might just need to add a graphic of your signature to the bottom of a document; on other occasions you may need to make a more significant change, without having access to the original document from which the PDF file was generated.

Canva makes it easy. Hover over "Design spotlight" at the top of the Canva home screen and click PDF Editor. When this view opens, click "Upload your PDF" and open your PDF using the file requester. You can now use Canva's regular image-editing tools to make changes such as adjusting text, moving frames, adding images and so on.

It's worth bearing in mind that the PDF standard isn't designed for editing. Depending on how the document was generated, you may hit some limitations and quirks. We were surprised to see that Canva changed our document font from Arial to IBM Plex Sans, but we had no problem changing it back in the browser-based editor. Canva also misplaced a yellow highlight from the text to which it had been applied in the original document, but we were easily able to drag this back into position.

## CANVA FOR SOCIAL MEDIA

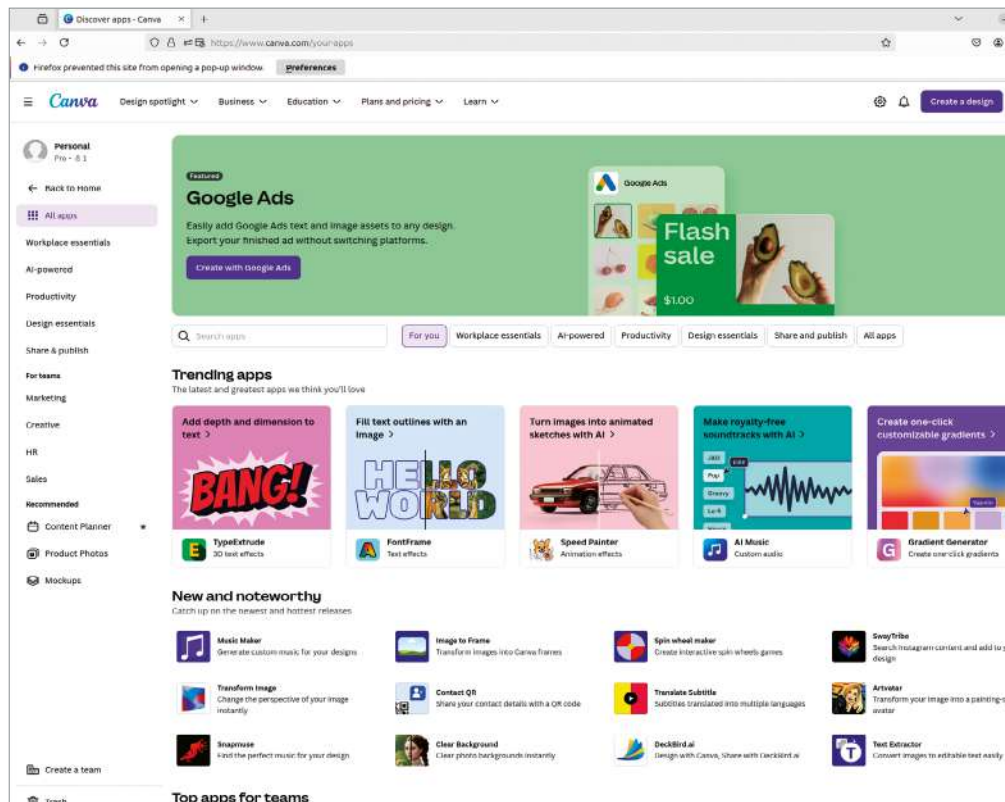
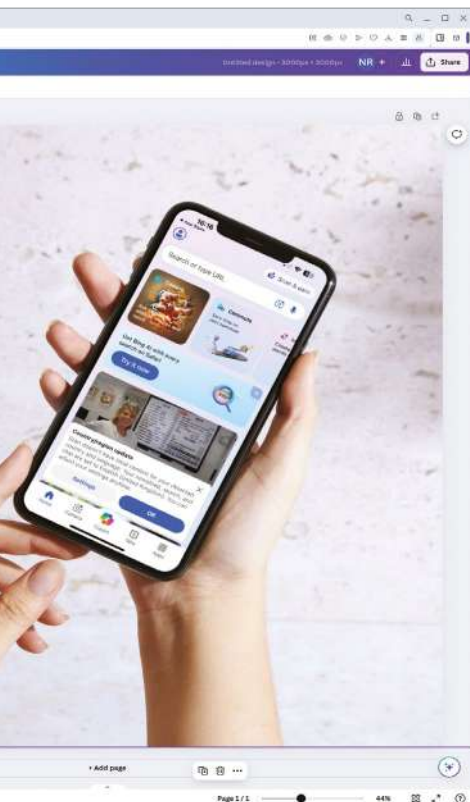
Canva is brilliant for creating assets for social media. The built-in tools significantly reduce the amount of work needed to produce professional graphics, and the templates are of consistently high quality, with smart colour palettes, layouts and font choices.

You can also post directly to social networks from within Canva, even if you're on the free tier. Once you've finished working on your design, simply click the Share button at the top of the screen, then click "Share on social" and select the network to which you want to send it. You'll need to connect to the network

in question before posting your first piece, but once you've done this you'll be able to post subsequent images without having to log in again.

Also in the Share menu you'll see options to share your work directly with other people by entering their email address, create a publicly viewable link or "Print with Canva". This latter option doesn't just send the asset to a local printer: it's a link to a print-on-demand service through which you can create bespoke headed notepaper, photobooks and promotional items such as stickers, coasters and address labels.





As well as directly editing the text in a PDF, you can use the Magic Write tool discussed above to shorten or spellcheck the copy – or rewrite it to make it more formal, change the tone and so forth.

## 5 Create mockups

We've mentioned that Canva is focused on marketing, and one of the best ways to promote a product is to show your customer what it looks like in situ. If you're selling art, hang it on a wall; if you're pitching an app, you'll want to show it running on a phone or tablet. And if the product doesn't exist yet, Canva's handy library of stock images makes it easy to fake it.

Let's imagine you want to create a promotional image for an app you're developing. Click the Upload button on the Canva homepage to upload your simulated screenshot – for our purposes we're using a screenshot of Microsoft Start. Click "Use in a new design" and, when it appears on the canvas, select it and click Edit Image. Select Mockups from the sidebar, then choose the object onto which you want to place it. There's a wide choice, including mugs, T-shirts, packaging, bags and outdoor advertising, but for this task it makes most sense to choose a phone – click the See All link beside Smartphones to view the full range.

Scroll through the options until you find one that works for your picture (be careful: some of them show the back of the phone). Canva

will automatically orient your imported image to fit the placeholder, which you can then resize to sit comfortably on your canvas. As you can see from the screenshot (*above left*), the effect is pretty convincing, and you can get professional results in seconds – much easier than comping the image together yourself.

## Taking things further

Canva's built-in capabilities can take you a long way, and it can even post directly to popular social media services (see "Canva for social media", *opposite*). You can extend it further by adding apps; you'll find these by returning to the homepage, clicking Apps in the sidebar, then scrolling through the marketplace.

Many of the available apps connect Canva to third-party services such as LinkedIn and Mailchimp, giving you more ways to export and share your work. Others work in the opposite

**ABOVE** Canva integrates with third-party apps for sharing and reusing designs

direction: capabilities such as SharePoint and Dropbox integration simplify the process of bringing existing assets into a Canva design, to ensure you're using consistent fonts, colour and other design elements across all of your creative output.

If you don't want to export your creations to an online platform, you can naturally save them locally, for further editing or just to store until needed. To do this, return to the homepage and click Projects in the sidebar, then scroll through your recent designs on the following screen. Click the three-dot icon that appears when you hover over the thumbnail of the project you want to download, then click Download. Canva will suggest a format and size based on the content of your project; you can customise these by dragging the size slider or selecting a paper size (for documents), and choosing a format from the File type menu. ●

THE EFFECT IS PRETTY  
CONVINCING, AND YOU  
CAN GET PROFESSIONAL  
RESULTS IN SECONDS





# TURN AN OLD ROUTER INTO A WI-FI EXTENDER

Darien Graham-Smith finds out how a spare router could give you a free signal boost





In the past few years there's been a steady stream of new Wi-Fi gear to spend your money on – first came Wi-Fi 6, then 6E, and now we're seeing Wi-Fi 7 routers and laptops appear. There's a fair chance that you've recently replaced your router, and may still have the old one knocking around somewhere.

If so, it doesn't need to be gathering dust – or at least, it could be doing something useful while it gathers dust. Almost any router can be turned into a Wi-Fi extender, enabling you to get a stronger, faster signal in remote areas of your home. However, the term “Wi-Fi extender” can refer to a few different sorts of setup, each with its own particular strengths and limitations. Here's what you need to know, along with our guide to giving a decommissioned router a second life.

## Access Point mode

Perhaps the simplest way to extend your network is to set up your old router as a wireless access point. This is the approach used by office networks the world over, and for good reason: in almost all cases, a wired connection is much faster and more reliable than a wireless one, so the extender network will be able to provide a full-speed connection to your main router.

Your setup can also be very simple indeed. You can set up an extended wireless network by just plugging one end of the cable into one of the LAN ports on your primary router, and the other end into the internet socket on the old router. The old router will broadcast its own wireless network, while the main router continues to handle addressing, port forwarding, security and internet access.

The downside of an AP setup, however, is obvious: to get the greatest benefit, you need to situate the AP in the part of your home where the main Wi-Fi signal is weakest. Almost by definition this is likely to be several rooms away from your primary router; however, in most households it's simply not practical to run an Ethernet cable from one end of the building to the other – and if you compromise on the location of the AP, devices won't get the best signal from it. This could well mean the AP approach isn't suitable for your needs.

If you do opt for an AP setup, it's also important to remember that, while a wired connection between the router and extender will normally be faster and more reliable than a wireless link, a gigabit Ethernet connection could still limit performance if you have lots of remote devices wanting to access the network at once. If you want the fastest possible speeds for internal network connections, consider

investing in a router or access point with 2.5GbE – remembering that you'll also need a 2.5GbE socket on the primary router to connect it to.

## Repeater mode

If you can't be running wires all around the house, the answer could be to set up your extender router in repeater mode. In this configuration the secondary router broadcasts its own Wi-Fi network for clients to connect to, and forwards traffic back to the main router over a second wireless connection – the same approach taken by dedicated plug-in Wi-Fi extenders.

There are challenges with this approach too, however. Management is more complicated than with an AP, as you'll be running two separate wireless networks on two different routers (although you can conceal this from the client devices to an extent – see “Same SSID, or different?” on p44). Devices connected to the extended network may have limited access to features on the primary router, such as parental controls and priority settings, and you may not be able to enable port forwarding for things such as games and media servers.

Location is still an issue, too. If you put the extender router at the far end of your home, in the area where your devices are struggling to get a good connection, then it too will have a weak connection to the primary router, and the extended network won't be any faster than the main one.

Conversely, if you put it too far away from your client devices, they'll get little performance benefit from it. In an ideal world you'd want to put it half-way between your main router and the area where you want to boost coverage, but in practice that may be complicated by the layout of your home, and the locations of your devices; you may need to do some experimenting.

Even once you've found the ideal location, the extended network may not be as fast as you'd hoped. As with an Ethernet connection, all devices connected to the extender have to share a single upstream connection to the main router, so bandwidth can get squeezed. What's more, the wireless backhaul connection itself consumes bandwidth, meaning there's less available for your devices. This is why upmarket Wi-Fi mesh systems use a dedicated radio band

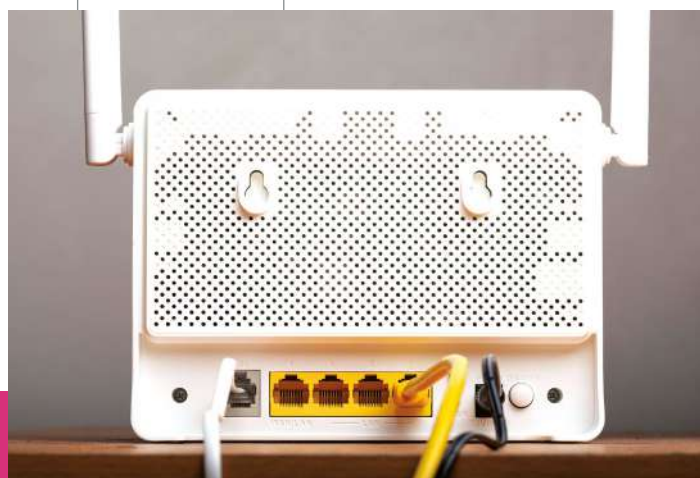
for backhaul, separate from the main wireless network. So while using an extender can work wonders for the stability and reliability of your connection, don't expect miracles on the performance front.

## Media bridge and mesh modes

Alongside AP and repeater modes, a few routers support a configuration called media bridge mode – or sometimes just bridge mode, although some manufacturers use this term to refer to AP mode.

In fact, media bridge mode is basically like AP mode in reverse. The extender router connects wirelessly to the main router, and makes the

**BELOW** Almost any router can be turned into a Wi-Fi extender



**The simplest way to extend your network is to set up your old router as a wireless access point**

network transparently available via its Ethernet ports. As with AP mode, this keeps things simple, as there's no splitting of the network and all management remains with the main router. Once again, though, you need to find a location for the extender where it receives a decent Wi-Fi signal from the main router – otherwise, what's the point? – but from where it's also practical to run Ethernet cables to your devices. It's mostly useful for connecting remote devices that need a wired network connection, which these days isn't a common scenario in many homes.

The last option you're likely to come across is mesh mode. If available, this could give you the best of both worlds: the secondary router connects wirelessly to the primary router and simultaneously broadcasts its own Wi-Fi network for clients to



connect to, just as in repeater mode, so you don't need to attach any cables at all. At the same time, the extended network is transparent, so devices connected to the extended network get the same network features and connectivity as if they were connected directly to the main router, and you can manage it all from the main router console.

Although mesh mode is attractively easy to set up and use, note that it suffers from the same bandwidth constraints as a repeater. It also requires proprietary software support on both the primary and secondary router, so you'll need to check whether it's an option for you: even if your routers are both from the same manufacturer, mesh operation won't necessarily be available on all router models.

## Selecting modes

There's no one-size-fits-all procedure for changing the operation mode of a router, but most networking providers use standard firmware across their whole range of routers, so the process will normally be the same across all modern routers made by a particular manufacturer. Here's our guide to which operation modes are available in the most popular router brands, and how to change them.

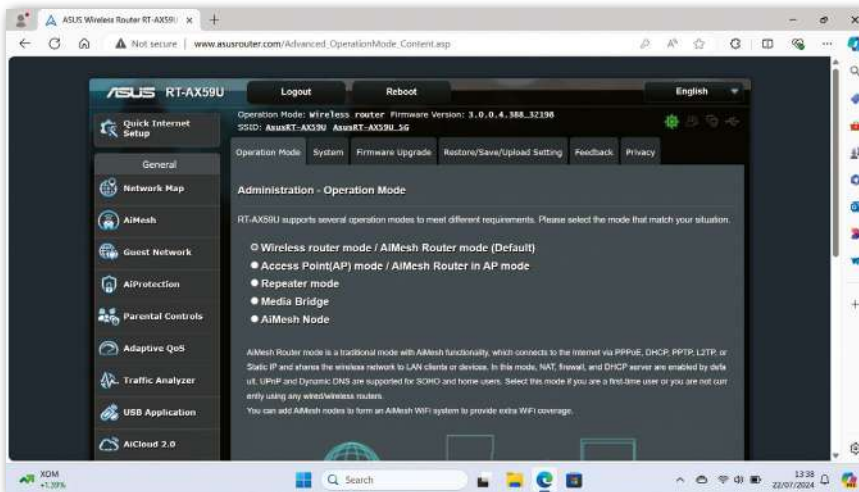
## Same SSID, or different?

If you're setting up an old router in repeater mode, you'll usually be prompted to choose a name and security passphrase for the extended network. You have two basic options here: use the same SSID and security settings as for the main network, or give the extender a different identifier.

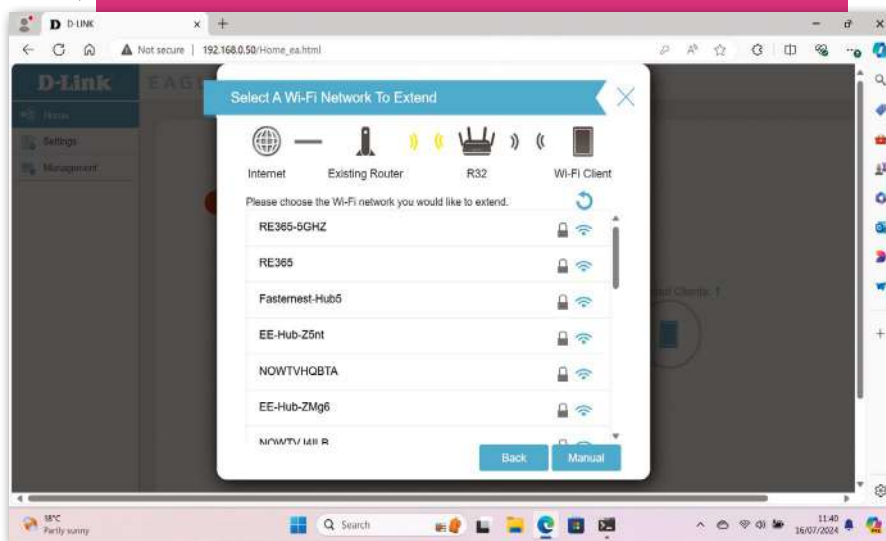
If you take the former approach – using the same SSID and security settings as the main network – then devices will be able to seamlessly switch between the two transmitters, automatically moving onto whichever is stronger. This can be convenient, but it's important to remember that a stronger signal doesn't necessarily mean faster. For example, a laptop located in the middle of the house might connect to the extender, even though the slightly weaker signal from the router would provide much better performance.

Giving the extended network its own name avoids this scenario, but it can produce the opposite problem: devices connected to the extender won't switch to the main network under any circumstances, unless the signal drops completely. Thus, you might be working right next to the primary router and getting a dreadful service because your laptop is still connected to the extender at the other end of the building.

There's no perfect solution that will suit all scenarios. You'll just have to weigh up your requirements and decide whether you want your devices to roam, or to bind themselves to one network or the other.



**Although mesh mode is easy to set up and use, it suffers from the same bandwidth constraints as a repeater**



**TOP** Asus routers can be easily configured to use different modes

**ABOVE** The D-Link management interface is pretty straightforward

## Asus

Asus routers are highly versatile when it comes to operation modes, with support for all four of the modes discussed above. The easiest way to set the mode is to perform a factory reset on the router, then log into the web management interface and click Advanced Settings. If your main router is also made

by Asus, you can now click "I want to set this device as an AiMesh node"; you'll see a guided walkthrough of how to configure the router as a managed subordinate of your main one.

Otherwise, click the middle link, labelled "Choose operation mode" to access the main menu. You'll see a

list of options including AP and Media Bridge modes, plus another chance to run the AiMesh setup wizard if you forgot to do so on the previous page.

If you choose Repeater mode the router will scan for nearby networks and ask you which you want to extend. Click your choice, then enter the passphrase for

that network; on the next page, where you're prompted to choose your IP settings, you'll probably want to select Automatic IP. You'll now be asked to set names and passphrases for each band of the extended network, and after a reboot your extended network will be ready to go.

## D-Link

D-Link routers don't support mesh setups, but otherwise they're pretty flexible. To access the mode settings, open the web management interface, click Settings in the left-hand pane, then select Operation Mode. You'll see a dropdown menu with options for router mode, extender mode and bridge mode, which in this case means AP mode.

If you want to use your D-Link router as a repeater, select Extender



mode and hit Save at the top of the screen; you'll now be prompted to wait while the router reconfigures itself and reboots.

After a few minutes, you'll see a pop-up telling you to reconnect to the router's network and open the web management interface. Make a note of the hostname shown (in my case it was `http://r32-a583.local`) as the router's IP address may have changed. Once connected, you'll see a welcome page warning "Existing Network Disconnected"; click the red button marked "Click to repair" and follow the steps in the wizard that opens to configure your D-Link router as a wireless repeater.

## Linksys

The standard Linksys firmware doesn't offer a repeater mode, but it does support AP and mesh configurations. You can access the former option in the Linksys mobile management app by connecting to the secondary router, tapping the menu icon at the top-left of the app

dashboard, then tapping Advanced Settings, followed by Internet Settings and Connection Type. If you're using the web management interface, click on Connectivity in the left-hand pane, then click Internet Settings, then click the Edit link next to "Type of Internet Connection" to reveal the Bridge Mode option.

If your primary and secondary routers are both made by Linksys, you can activate mesh mode by performing a factory reset on the second router and let it boot up in setup mode. Now open the Linksys mobile app, select "Set up a new product", then tap "Add another node" when prompted and follow the onscreen instructions.

## Netgear

Like Linksys' devices, Netgear routers don't offer a repeater function, and you also can't connect the company's routers in a mesh configuration – that capability is restricted to the company's dedicated Orbi mesh systems.

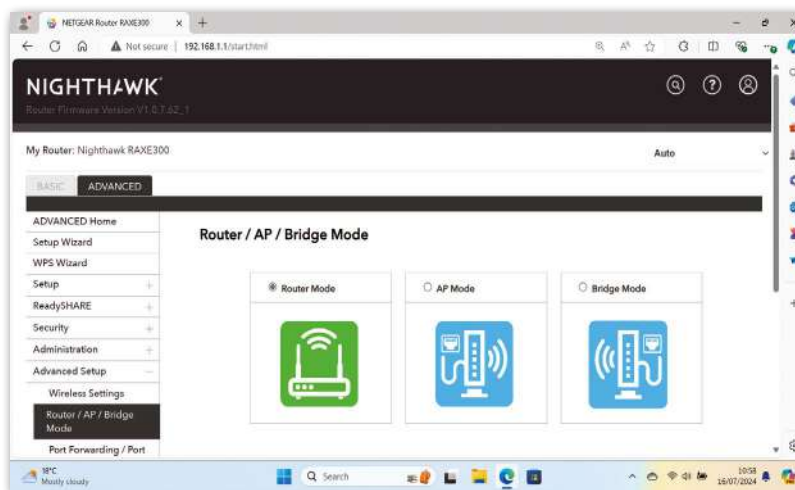
## Third-party firmware

If your old router doesn't have a repeater mode, you might still be able to turn it into a repeater by replacing its native firmware with the free OpenWrt platform. This is available for a huge range of routers, from dozens of different manufacturers. At [tinyurl.com/361openwrt1](http://tinyurl.com/361openwrt1) you'll find a searchable table where you can check whether your model is supported.

If your router does work with OpenWrt, the installation process is normally simple. In most cases you can download the appropriate OpenWrt image file and install it from your router's management interface, just like a regular firmware update. You'll find more details at [tinyurl.com/361openwrt2](http://tinyurl.com/361openwrt2).

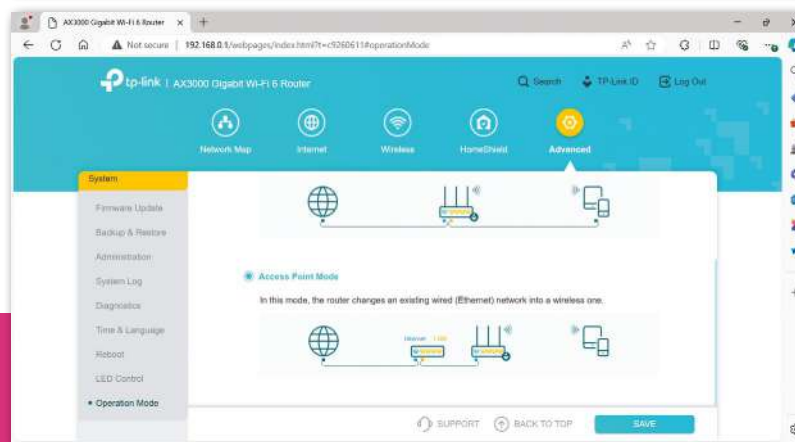
Once your router is running OpenWrt you can make it work as a repeater by following a few simple steps in the graphical UI, as described at [tinyurl.com/361openwrt3](http://tinyurl.com/361openwrt3). Note that this method isn't guaranteed to work with all routers: if you hit a problem then you'll find links at the bottom of the documentation page to alternative methods using the WDS (Wireless Distribution System) or 802.11s mesh networking standards. These may be more robust, but they're more technically complicated to set up.

If you can't get it working, or subsequently decide you don't want to use OpenWrt any more, you can re-flash the router with an official image from the manufacturer to go back to the standard firmware.



**LEFT** You can enable AP mode in Netgear's web management portal

However, you can enable AP mode in the router's web management portal. To do so, switch to the Advanced tab, click to expand the Advanced Setup options in the left-hand pane, then click the option labelled Router/AP/Bridge mode. From here you can click to select AP mode or Netgear's media bridge mode, in which the router connects wirelessly to your primary router and makes the network available to any devices connected to the Netgear's Ethernet ports.



**LEFT** TP-Link doesn't offer many options to extend a network

## TP-Link

TP-Link routers are sadly quite short of options for extending an existing network. They don't normally have a Wi-Fi repeater mode, and while the company's OneMesh technology allows TP-Link routers to detect and manage compatible extender devices automatically, it doesn't support using a secondary router as an extender.

The best you can do with a spare TP-Link router is to connect it to your main router via Ethernet and use it as a wireless AP. You can enable this option from the router's initial web-based setup wizard by clicking the Change Mode link at the top of the page and selecting AP Mode in the window that opens. Alternatively, in the main management console you can click Advanced in the upper part of the window, then click System in the left-hand pane and choose Operation Mode from the submenu that appears. A window opens offering the choice of Wireless Router Mode and Access Point Mode; select the latter, then hit the blue Save button to confirm your choice.

**Most networking providers use standard firmware across their whole range of routers**



# Get closer to your customers with 3CX

The latest updates to 3CX's Phone System and the softphone apps will connect your team to your customers like never before

**A**ny 3CX customer knows two things: the company has an almost obsessive compulsion to offer fantastic value for money, with a “free forever” mantra that applies to small businesses in particular; and it matches that with its untiring desire to improve its products.

It does that by listening to what customers want, as can be clearly seen in the latest update: 3CX V20 Update 2. If there's an overriding theme to this release, it's about getting you closer to your customers. That means understanding them better, helping them reach the right people within your organisation more easily, and protecting their privacy.

In this overview, we go through the key improvements, but it's worth emphasising that this isn't everything that's in the update. 3CX also has a new high-priority setting for better voice quality, while 3CX partners who host the service for companies should take a deep look at the new 3CX Multi-Tenant feature (see [tinyurl.com/3cxmulti-tenant](https://tinyurl.com/3cxmulti-tenant)).

## ■ Adding AI magic

This isn't about adding AI for the sake of it. Instead, 3CX has looked at how AI can help its customers solve real problems.

The solution in question is OpenAI's WhisperAI tool, which transcribes speech. While automatic transcription has been around for a while, it can be difficult to configure properly, so by integrating it with this latest update 3CX is bringing such tools to everyone. No expertise required.

As well as summarising your calls in a search-friendly manner, 3CX will also assign each transcribed call with a sentiment score. A “1” implies a mostly negative customer experience, while “5” means mostly positive. This is based on both the agent's and the caller's tone.

Combined with other data, such as how long people have been kept waiting in call queues, it's possible to use this information to take action to stop negativity (and facilitate positive calls and higher agent proficiency) in the future.

**BELOW 3CX's new AI feature assigns each call with a sentiment score**

| 3CX Admin Console                                                                 |                | Queue Answered Calls By Waiting Time |                     |                |              |           |          |                     |
|-----------------------------------------------------------------------------------|----------------|--------------------------------------|---------------------|----------------|--------------|-----------|----------|---------------------|
| <div>Team</div> <div>Chat</div> <div>Meet</div> <div>Calls</div> <div>Panel</div> | Dashboard      | Range: Today Queue: Support - EN     |                     |                |              |           |          |                     |
|                                                                                   | Users          | Queue                                | Call Time           | Destination    | Caller ID    | Sentiment | Ringing  | Answer Time         |
|                                                                                   | Voice & Chat   | 819 - Support - EN                   | 12/06/2024 14:52:24 | 100 John Smith | +44123456789 | 3         | 00:00:50 | 12/06/2024 14:53:15 |
|                                                                                   | Phones         | 819 - Support - EN                   | 12/06/2024 13:28:07 | 100 John Smith | +44123456789 | 3         | 00:00:56 | 12/06/2024 13:29:02 |
|                                                                                   | Outbound Rules | 819 - Support - EN                   | 12/06/2024 11:45:10 | 100 John Smith | +44123456987 | 3         | 00:00:12 | 12/06/2024 11:45:22 |





**ABOVE** Apple CarPlay support lets you make calls on the road

You can also take advantage of 3CX's new AI reports. With summaries and sentiment scores stored for each call, many reports have now been enhanced with a sentiment score average, allowing you to see the general sentiment of a particular queue, ring group or agent.

### ■ Presence in 3CX and Teams

We're all well aware of how useful presence information can be within teams, especially those distributed across different locations, but it can be extremely challenging to keep presence information synchronised across software platforms. With V20 Update 2, you can easily synchronise Microsoft Teams presence to 3CX, or from 3CX to Teams.

Previously, this was possible – but only if you went through the arduous step-by-step process of configuring Microsoft Teams Direct Routing. Now, so long as you've integrated Microsoft 365 correctly, it will simply work.

### ■ Greater admin control

This update isn't just great for users; it's great for admins, too. You now have granular control down to the user level, in a way that wasn't possible before. For example, you can now configure per user whether they can see call logs of other users in the group – and whether they can hide their calls from other users in that group.

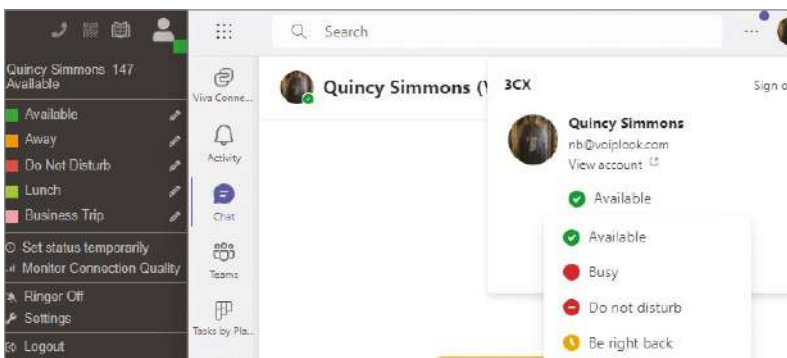
You can also control whether the presence of other users is shown or not, and whether they can perform call operations. For example, whether they can transfer and divert calls, or perhaps pick up a call currently with the Digital Receptionist.

Admins can now see who's connected to your PBX – and then terminate that connection if necessary. For the moment, only web client connections are shown, but this will include connections via apps in the future.

### ■ Private videoconferencing

3CX understands that some companies (and government institutions) will be concerned about sharing their IP and secrets with conferencing providers. In that situation, it's vital that all voice and video calls stay within the organisation.

In Update 2, you can now configure your own Video



**BELOW** Presence information can be synced between 3CX and Teams

## IMPROVED PHONE APPS

Quite apart from improving its main Phone System, 3CX constantly improves its software phone offerings too. Here's a quick rundown of what's new in the Windows and iPhone applications.



### New Windows softphone

If you like answering calls on a physical phone – rather than from your softphone – then the new Windows softphone allows you to do just that. You simply need to have a deskphone already configured to your account, with switching devices controlled from the Settings page.

You can also access an all-new, quick action panel for faster logging in and out of queues, while a simple ringer on/off feature is surely self-explanatory!

While smaller companies should still download 3CX's secure Windows softphone app directly from the Microsoft Store, if you want to control the roll-out and updating of the software yourself then there's now an option to deploy the Windows softphone using the MSIX app package format.



### New iOS app

Apple iPhone owners can now make calls on the road using the updated iOS app thanks to support for Apple CarPlay. For example, say "Hey Siri, call Kate using 3CX" and it will work out who to call from your address book.

The new app also makes it simple to read and reply to messages: when you receive a message, a notification will appear on your dashboard and the message will be read out to you. To reply, tap on the notification, choose "reply" and Siri will prompt you to dictate the message and will then send it.

Finally, it's now possible to access your voicemail using voice commands. And it couldn't be simpler: just say "Hey Siri, call voicemail using 3CX".



### New Android app

3CX's new Android app adds a bunch of features that will help you get closer to your customers. Top of the list, you can now add Microsoft, CRM, personal or company contacts while on a call to an unsaved number (simply tap on the Add Contact label from the dialer interface).

There's also a new tool to monitor connection quality while on a call, which will generate a report afterwards, and the ability to quickly elevate an active call to a conference with colleagues – perfect for escalating a complaint or bringing in technical experts.

Conferencing Server, hosted and controlled by you, ensuring your organisation is the only one to hear (or transcribe!) your calls. Learn how to configure a private video conference server at [tinyurl.com/3cxprivate](https://tinyurl.com/3cxprivate).

### ■ Try 3CX for free

Want to try 3CX for free? It's easier than ever thanks to a new deployment wizard and a streamlined sign-up process for 3CX instances.

Whereas before all potential customers would go down the same route, 3CX has now separated smaller customers from larger enterprises. Small businesses still get 3CX free forever. However, Enterprise customers – who require more features than the free version offers – get a free two-month 3CX PRO trial with the options to self-host, hosted by 3CX or download on-premise.

3CX makes it easy for SMBs to get a free communications system, hosted by 3CX. However, one of its key strengths is catering to companies with 25 to 1,000 user installations who can self-host and who require a more advanced and sometimes complex communications system.

3CX offers a solution that can cost a fraction of its competitors while never compromising on features. Sign up today and you'll see just how easy it is to set up and manage too. ●

**Try 3CX FREE** [www.3cx.com/signup](https://www.3cx.com/signup)

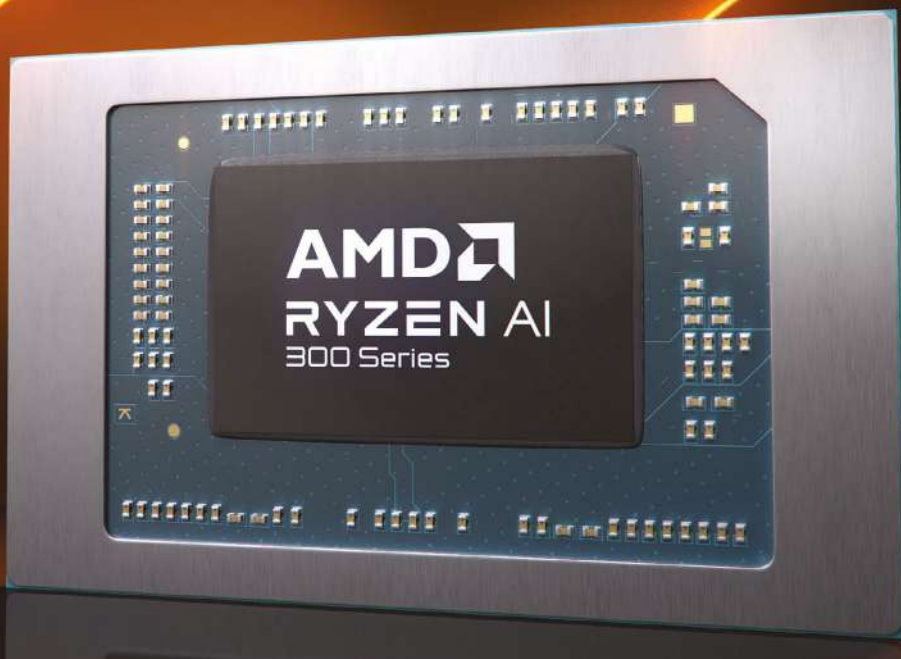
# Reviews

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## AMD Ryzen AI 300 series

This landmark release not only provides a debut for Zen 5 architecture but also marks AMD's all-out assault on AI



**Y**ou have to sympathise with AMD. Thanks to its powerful and power-efficient Zen architecture, it has slowly chipped away at Intel's laptop dominance for the past five years, to the point where it had doubled its market share. And then party-pooper Qualcomm comes along with its Snapdragon Elite chips, which were the first to meet the criteria for Microsoft's Copilot+ PCs.

But AMD is battling back thanks to its Ryzen AI 300 series, which also meet Microsoft's criteria for Copilot+ PCs (although, at the time of writing, they are yet to be certified). In what AMD is calling its third-generation Ryzen AI chip, it has overhauled the architecture to deliver leadership in productivity, content creation and games. Or so it claims; Qualcomm looks at things quite differently.

Its undeniable advantage over Qualcomm is that the Ryzen AI 300 chips stick to the familiar x86 architecture, which guarantees compatibility with 35 million Windows apps. Of these, AMD says, more than 100,000 are games. Snapdragon-powered laptops, on the other hand, must use Microsoft's Prism translation to convert from x86 to Arm on the fly – something it does astonishingly well in 95% of cases.

As for Intel, we must wait for its Lunar Lake processors, which are due in September. I hope to test the first tranche next month. For now, Core Ultra 9 chips are Intel's closest rivals to the Ryzen AI 300 series.

### ■ New architecture

AMD has released a trio of Ryzen AI 300 chips, but the three laptops I've tested so far – all made by Asus and reviewed over the following three pages – feature the Ryzen AI 9 HX 370. The HX 375's sole advantage is that it offers more AI power, with a beefed up neural processing unit (NPU) that's rated at 55 tera operations per second (TOPS) compared to 50 for the HX 370.

The HX 365 is a bigger step down than it sounds, with ten cores rather than the 12 inside its siblings. It also features lesser Radeon 880M graphics, which has roughly 30% fewer shading units, compute units,

**ABOVE** The Ryzen AI 300 series is a strong debut for AMD's Zen 5 architecture



**ABOVE** Laptops such as the Asus ProArt P16 are based on the Ryzen AI 9 HX 370

ray-tracing cores and texture mapping units than the Radeon 890M.

All the chips feature AMD's new Zen 5 architecture, with a mix of full-size and compact cores. The latter are called Zen 5c. This may sound like Intel's mix of performance P-cores and efficiency E-cores, but that's not wholly accurate. Zen 5c cores uses the same instruction set as Zen 5, while P-cores and E-cores don't – and that can lead to scheduling issues and thus delays. Also, Zen 5c cores still support simultaneous multithreading, or SMT, which means they can run two streams of instructions on the same core.

So why use Zen 5c cores? To save space, money and power: on the Ryzen HX 370, the eight Zen 5c cores share 8MB of Level 3 cache compared to 16MB available across the four Zen 5 cores, and they can't peak to such high frequencies. While that has a

AMD Ryzen AI 300 Series

|                   | CORES/THREADS | ARCHITECTURE          | MAX BOOST | GRAPHICS    | TOTAL TOPS | NPU TOPS |
|-------------------|---------------|-----------------------|-----------|-------------|------------|----------|
| Ryzen AI 9 HX 375 | 12/24         | 4 x Zen 5, 8 x Zen 5c | 5.1GHz    | Radeon 890M | 85         | 55       |
| Ryzen AI 9 HX 370 | 12/24         | 4 x Zen 5, 8 x Zen 5c | 5.1GHz    | Radeon 890M | 80         | 50       |
| Ryzen AI 9 HX 365 | 10/20         | 4 x Zen 5, 6 x Zen 5c | 5GHz      | Radeon 880M | 73         | 50       |



performance hit, it also makes it easier for AMD to fit more Zen 5c cores onto a die; AMD says Zen 5c cores take up around 25% less space than Zen 5.

## AI boom?

You may remember that in late 2023 AMD's Ryzen 7040 series chips introduced Ryzen AI, with up to 10 TOPS. And that, a few months later, it unlocked a further 6 TOPS in Ryzen 8040 processors. But that 16 TOPS total fell a long way short of the 40 TOPS minimum that Microsoft set for Copilot+ PCs, which is why the Ryzen AI 300 series are AMD's first chips to qualify for this status.

There's a certain amount of "so what?" about all this. If you read our feature on Windows 11 24H2 updates (see p26), we highlight all the AI-only additions, and none falls into the must-have category. I question how many people need mediocre live translation in their lives, or care that background blurring in video calls is more power-efficient when shunted onto an NPU, or will ever use Cocreator to turn sketches into AI-enhanced images.

The counter-argument is that things are changing. That within a couple of years, the software we use – from Adobe, BlackMagic, Microsoft et al – will be tuned to take advantage of NPUs. And there are already signs of this, via plugins and updates. But right now, local AI feels of more interest to companies selling the hardware than the mainstream user.

## Zen 5 speed boost

So, what difference does Zen 5 make to the thing that everyone cares about: power? AMD is focusing on its instructions-per-clock uplift, claiming a 16% average across workloads. It manages this through higher data bandwidth, better branch prediction and a reduction in cache latency, and our colleagues at Tom's Hardware have written a deep dive if you wish to discover all the details ([tinyurl.com/361zen5](https://tinyurl.com/361zen5)).

Here, I'm going to focus on results. In Geekbench, the uplift is significant compared to even the fastest system we've seen with AMD's Ryzen 9 8945HS chip inside – the Asus ROG Zephyrus G14 (see issue 356, p58) – with the ProArt P16 (see p50) scoring 2,891 in the single-core test and 15,399 when all eight cores were called into action. That compares to 2,580 and 12,891 for the G14. But the fastest Snapdragon-powered laptop, the Samsung Galaxy Book4 Edge with a top-end X1E-84-100 inside, returned 2,897 and 15,819.

I don't have Cinebench 2024 results for the ROG Zephyrus, but AMD should be happy with the P16's returns of 117 (single core) and 1,217

### GEEKBENCH 6 (SINGLE-CORE)

|                                                                              |       |
|------------------------------------------------------------------------------|-------|
| <b>Samsung Galaxy Book4 Edge</b><br>X1E-84-100, Adreno GPU, 16GB RAM         | 2,897 |
| <b>Asus ProArt P16</b><br>Ryzen 9 HX 370, RTX 4070, 64GB RAM                 | 2,891 |
| <b>Asus ProArt PX13</b><br>Ryzen 9 HX 370, RTX 4070, 32GB RAM                | 2,853 |
| <b>Asus Zenbook S 16</b><br>Ryzen 9 HX 370, Radeon 890M, 32GB RAM            | 2,805 |
| <b>Asus Vivobook S 15 OLED</b><br>X1E-78-100, Adreno GPU, 16GB RAM           | 2,432 |
| <b>Samsung Galaxy Book4 Pro</b><br>Core Ultra 7 155H, Arc graphics, 16GB RAM | 2,345 |

HIGHER IS BETTER

### DIRT 5 (1200P, LOW, FPS)

|                                                                              |     |
|------------------------------------------------------------------------------|-----|
| <b>Asus ProArt P16</b><br>Ryzen 9 HX 370, RTX 4070, 64GB RAM                 | 185 |
| <b>Asus ProArt PX13</b><br>Ryzen 9 HX 370, RTX 4070, 32GB RAM                | 180 |
| <b>Asus Zenbook S 16</b><br>Ryzen 9 HX 370, Radeon 890M, 32GB RAM            | 51  |
| <b>Samsung Galaxy Book4 Pro</b><br>Core Ultra 7 155H, Arc graphics, 16GB RAM | 42  |
| <b>Samsung Galaxy Book4 Edge</b><br>X1E-84-100, Adreno GPU, 16GB RAM         | 29  |
| <b>Asus Vivobook S 15 OLED</b><br>X1E-78-100, Adreno GPU, 16GB RAM           | 28  |

HIGHER IS BETTER

(multicore). The Snapdragon-powered Book4 Edge performed better in the single-core test with a 125 result, but 981 in the multicore section is less impressive.

In short, based on these CPU-intensive tests, Zen 5 gives a clear boost over Zen 4. From an AMD engineering point of view, job done.

## Gaming action

AMD has also updated the graphics built into the Ryzen AI 300 series, with the tagline of "high-quality HD gaming" and the promise of being anywhere between 27% faster (*Far Cry*) and 65% faster (*Cyberpunk 2077*) than the Arc graphics built into Intel's Core Ultra 9 185H and the Snapdragon X Elite's Adreno graphics.

To test, I used 1080p Low settings, and with 51fps in *Dirt 5*, 49fps in *Shadow of the Tomb Raider* and 54fps in *Cyberpunk 2077* there's definitely the chance for gaming on the Asus Zenbook S 16 (see p52). That compares to 42fps, 45fps and 33fps for the

### GEEKBENCH 6 (MULTICORE)

|                                                                              |        |
|------------------------------------------------------------------------------|--------|
| <b>Samsung Galaxy Book4 Edge</b><br>X1E-84-100, Adreno GPU, 16GB RAM         | 15,819 |
| <b>Asus ProArt P16</b><br>Ryzen 9 HX 370, RTX 4070, 64GB RAM                 | 15,399 |
| <b>Asus ProArt PX13</b><br>Ryzen 9 HX 370, RTX 4070, 32GB RAM                | 15,029 |
| <b>Asus Vivobook S 15 OLED</b><br>X1E-78-100, Adreno GPU, 16GB RAM           | 14,263 |
| <b>Asus Zenbook S 16</b><br>Ryzen 9 HX 370, Radeon 890M, 32GB RAM            | 13,239 |
| <b>Samsung Galaxy Book4 Pro</b><br>Core Ultra 7 155H, Arc graphics, 16GB RAM | 12,118 |

HIGHER IS BETTER

### CINEBENCH 2024 (MULTICORE)

|                                                                              |               |
|------------------------------------------------------------------------------|---------------|
| <b>Asus ProArt P16</b><br>Ryzen 9 HX 370, RTX 4070, 64GB RAM                 | 1,217         |
| <b>Asus ProArt PX13</b><br>Ryzen 9 HX 370, RTX 4070, 32GB RAM                | 1,189         |
| <b>Samsung Galaxy Book4 Edge</b><br>X1E-84-100, Adreno GPU, 16GB RAM         | 981           |
| <b>Asus Zenbook S 16</b><br>Ryzen 9 HX 370, Radeon 890M, 32GB RAM            | 915           |
| <b>Samsung Galaxy Book4 Pro</b><br>Core Ultra 7 155H, Arc graphics, 16GB RAM | 608           |
| <b>Asus Vivobook S 15 OLED</b><br>X1E-78-100, Adreno GPU, 16GB RAM           | Would not run |

HIGHER IS BETTER

Samsung Galaxy Book4 Pro (see issue 355, p64), which uses the Arc graphics built into the Core Ultra 7 155H – identical graphics to those in the 185H but with a 2.25GHz boost clock rather than 2.35GHz. The Galaxy

Book4 Edge averaged 29fps and 33fps in the first two games, but couldn't run *Cyberpunk 2077*.

If you're after a casual gaming laptop, the Ryzen AI HX 370 is clearly an excellent choice, and while I would expect laptops with a Ryzen AI HX 365 to be roughly 20% slower, you should find most games are playable.

**"Based on CPU-intensive tests, Zen 5 gives a clear boost over Zen 4. From an AMD engineering point of view, job done"**

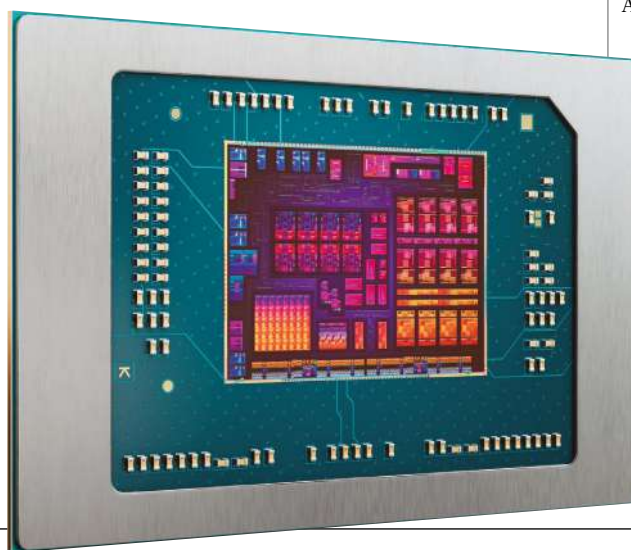
**BELOW** The chips are compatible with millions of existing Windows apps

## Final thoughts

The next big test for AMD's Ryzen AI 300 series will come when Intel releases Lunar Lake, but with a focus on AI enhancements rather than all-out power, I don't expect it to overtake the Ryzen AI 300 overall.

Where Intel and Qualcomm both have the edge over AMD is efficiency. All the AMD presentations I've seen on the Ryzen AI 300 focus on performance rather than performance-per-watt, while AMD's press release made one mention of battery life – that it was "exceptional". From the three laptops I've tested so far, I would dispute the use of that word; Qualcomm has the clear lead, and I expect Intel to be close behind.

But overall, this is a strong debut for AMD's Ryzen AI 300 chips. If you're looking for fast performance now, and would like to experiment with local AI, then one of the three laptops on the following pages will make a fine choice. **TIM DANTON**





## Asus ProArt PX13

A pocket-sized dynamo, this convertible lacks for nothing, exudes industrial chic, and the price is easy to justify

SCORE ★★★★★

PRICE 2TB/RTX 4070, £2,083 (£2,500 inc VAT) from [uk.store.asus.com](https://uk.store.asus.com)

Not content with being the first company to announce laptops with AMD's Ryzen AI 300 chips inside, Asus has built a new brand of laptop around them: together with the P16 opposite, these first ProArt laptops are aimed at designers and artists alike. Think Pantone-calibrated screens with excellent colour coverage, discrete GeForce RTX 40 series graphics and all the power that comes with AMD's latest family of chips.

Asus is selling two versions of the 13in PX13: one with RTX 4060 graphics, 24GB of RAM and a 1TB disk, and the other (as tested) with an RTX 4070, 32GB of RAM and a 2TB SSD. Both include AMD's Ryzen AI 9 HX 370, with Asus supplying it with up to a whopping 65W of power. That's possible thanks to a relatively thick 17.7mm rear, which leaves space for a meaty pair of fans. You can see the boost they give if you compare its results on the previous page to the slimmer Asus Zenbook S 16 (see p52).

The PX13 is still remarkably compact, with a footprint little larger than a hardback book. It's an eye-catching matte black design, and Asus' claims of smudge resistance held up in practice; I suspect this laptop will be a looker even after years on the move, right down to the Asus ProArt logo subtly etched into the bottom left of the lid, next to a pair of textured hinges. Those hinges allow the lid to swivel through 360°, so artists can use the PX13 as a tablet via the bundled Asus Pen 2 stylus.

Asus also embeds a dial into the top left of the touchpad, which can be used in creative apps such as

Photoshop and Premiere Pro to slide settings up or down – and Windows' settings, such as brightness. Anything that works well with a normal dial does so here, and combined with the excellent, glass-topped touchpad you may find you don't need a mouse when away from your desk.

One area of weakness is battery life. The PX13 lasted for 9hrs 11mins in PCMark's light-use Modern Office test, and there's no way this laptop will keep going for a day's worth of creative tasks. The supplied 200W power supply is chunky, weighing 470g; if you don't need full power, you can also charge the PX13 at up to 100W using one of the two USB-C 4 ports.

There's also an HDMI output, 3.5mm combo jack, single USB-A port and microSD card slot. Wi-Fi 7 and Bluetooth 5.4 are both present, too.

Other than its Pantone certification, the screen is typical of OLED panels. Others go

brighter, with the PX13 peaking at 372cd/m² in our tests, and that meant it wasn't easy to read under the sun's glare – a glossy finish doesn't help. But it covers 99% of the DCI-P3 gamut, and if you head into Asus' comprehensive MyAsus app you can switch between colour gamuts (sRGB, DCI-P3 and Display P3). Colour accuracy is beyond reproach, with an average Delta E of 0.42.

MyAsus is also where to go if you want to tweak performance settings. You can prioritise quietness in Whisper mode or push up to Performance Mode when plugged in. Using this, the PX13 produced a suite of

**ABOVE** The striking design and formidable power within make the PX13 a fine choice



**“The ProArt PX13 wins for looks and speed, and offers creatives everything will need on the job – including a colour-calibrated screen”**

**LEFT** The thick rear of the laptop allows room for two meaty fans

**BELOW** Artists can use the PX13 as a tablet, and a stylus is provided, too

excellent scores, as we would expect from the new Ryzen AI chip, RTX 4070 graphics and 32GB of RAM. At the panel's native resolution it scored 78fps in *Dirt 5* and 60fps in *Cyberpunk 2077* at High settings. Nvidia's Studio drivers mean that 3D acceleration is easily exploited by supported professional apps, too. Considering this laptop's size, you can tap into a stunning amount of power. However, the ProArt P16 is faster still.

There's more entertainment potential thanks to a pair of excellent speakers, and Asus also caters for the duller things in life. The 1080p webcam captures all the detail you'll need for work calls, with top-notch colour balance, while a three-mic array can cancel out background noise. Despite the chassis' narrow width, I also enjoyed typing on the keyboard thanks to its deep travel and sensible layout, with a single-height Enter key its only blight.

I'm less impressed by the software and support package Asus offers for ProArt laptops. They ship with Windows 11 Home, while a single year of collect-and-return cover is poor for a professional laptop. However, I don't doubt the build quality, with the all-metal chassis providing an excellent level of protection; Asus claims that it “exceeds” the MIL-STD-

810H standard and, with a dust filter to protect the internals, it's even suitable for extreme environments. But clearly, the PX13 isn't rugged in the same way as the Getac S510 (see p62).

Despite my occasional criticism, I can't help but be impressed by the ProArt PX13. It wins for looks and speed, and offers creatives everything will need on the job – including a colour-calibrated screen, stylus and shortcut dial. Yes, its battery life is weak by modern standards and it's expensive, but its many other redeeming features mean I don't hesitate to give it five stars and a Recommended award. **TIM DANTON**

### SPECIFICATIONS

12-core/24-thread AMD Ryzen AI 9 HX 370 processor • 8GB Nvidia GeForce RTX 4070 graphics • 32GB LPDDR5X RAM • 13in 60Hz OLED touchscreen, 2,880 x 1,800 resolution • 2TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2 x USB-C 4 • USB-A 3.2 Gen 2 • HDMI 2.1 • 3.5mm combo jack • microSD card reader • 73Wh battery • Windows 11 Home • Asus Pen 2 • 298 x 210 x 15.8-17.7mm (WDH) • 1.4kg • 1yr C&R warranty • part code 90NB14K1-M000UO

### BATTERY LIFE





# Asus ProArt P16

The ideal platform for AMD's new Ryzen AI chips, this stylishly understated professional laptop does it all

**SCORE** ★★★★★

**PRICE** 2TB/RTX 4070, £2,416 (£2,900 inc VAT) from uk.store.asus.com

**W**hile I could sum up this review in six words –

like the PX13 opposite, only bigger – that doesn't do the ProArt P16 justice. Yes, it shares many of the same design hallmarks and specs as its little brother, but this 16in laptop can justly be called a graphics workstation.

The bigger chassis means more room for fans and cooling systems than the PX13, and the CPU benefits from a maximum thermal design power (TDP) of 70W rather than 65W. Asus evidently can't make room for a GeForce RTX 4080 within this still-slender chassis, instead sticking to the RTX 4070 found in the top-end PX13. What you do get, if you select the 2TB model, is 64GB of RAM; the 1TB/32GB version costs £2,600 inc VAT.

I tested the more expensive unit, and it was a few per cent ahead of the PX13 throughout my tests. In *Cyberpunk 2077* and *Dirt 5* it averaged 102fps and 122fps at 1080p High, compared to 91fps and 99fps. It was a similar story in the demanding SPECperfvew 2020 viewsets: taking Catia, 3ds Max and Creo as examples, the P16 returned 67, 99 and 110, while the PX13 scored 65, 96 and 109. These scores are admittedly humbled by the towering monsters in our graphic workstation PCs Labs (see p78).

Honours were even in our rundown tests, where the P16's larger 90Wh battery evened out the greater power consumption required by its 16in panel. Here, though, a battery life of around nine hours under light use seems eminently reasonable compared to laptops with similar graphical power – usually gaming machines – and I can't imagine that

## BATTERY LIFE



many people will want to lug this 1.9kg beast around with them despite its slim dimensions. If you want to use that CPU at full power, you'll need to find space in your bag for the 200W power supply, too.

This uses a proprietary connector, so both USB-C ports are free for connecting peripherals. The faster USB 4 port sits on the left, alongside HDMI, USB-A and 3.5mm connectors, while a slower USB-C 3.2 Gen 2 port is on the right alongside a

second USB-A port and full-size SD Express 7 card reader. There's no RJ45 port, which is a shame when there's so much spare space, but Wi-Fi 7 offers some compensation.

Asus doesn't squeeze in a number pad, but don't expect a roomier keyboard than the PX13 as a result. So far as I could tell, they're identical from the size of the keys to the half-height cursors and the single-height Enter key. That's fine when you're tight for space, as is the case for the PX13, but I would like separate Home, End, PgUp and PgDn keys on a laptop of this size, and for the cursors to be full height and separated out. At least Asus has increased the size of the glass-coated touchpad, which comes complete with the DialPad I describe opposite.

The main beneficiary of Asus' decision not to include a number pad is the audio. Speakers sit on either side of the keyboard, with bass, depth and subtlety to match standalone speakers. Then we come to the expanse of screen, with a 3,840 x

**ABOVE** The P16 offers plenty of graphical potency in its well-designed chassis



**"It shares many of the same design hallmarks and specs as its little brother, but this laptop can justly be called a graphics workstation"**

**LEFT** There are plenty of ports on the sides, and Wi-Fi 7 is included

**BELOW** Asus packs amazing speakers on either side of the P16's keyboard



2,400 resolution to play with – a fraction beyond 4K. It's Pantone-calibrated while an average Delta E of 0.43 speaks to its colour accuracy. Gamers should note that it peaks at 60Hz while HDR video editors won't be impressed by a 500cd/m<sup>2</sup> peak when viewing HDR content. Asus states a 400cd/m<sup>2</sup> maximum for SDR, but I measured a more modest 377cd/m<sup>2</sup>.

I've no complaints about colour coverage (100% of DCI-P3) or the level of user control, as the MyAsus app lets you pick from four colour profiles: native,

sRGB, DCI-P3 and Display P3. You can also use MyAsus to play around with microphone settings, but I found the mics worked fine in the default mode. As did the 1080p webcam, although streamers might have hoped for a higher resolution.

More surprising is that Asus supplies Windows 11 Home rather than Pro, while a single-year C&R warranty is basic. Thankfully, the P16 is built like a tank, while the matte black metal chassis proved resistant to my fingerprints and scratches.

You can also access this laptop's internals if you want to upgrade the SSD, or even add a second one in the spare slot. However, all the RAM is embedded on the motherboard, so if you want 64GB, take the hit at the time of purchase.

And it is a hit; the main reason this machine doesn't earn five stars is that I expect near-perfection for this price and, while I can forgive sacrifices in an ultraportable such as the PX13, I'm less forgiving when there's this much space to play with. All that said, the ProArt P16 is a remarkably well-made and powerful laptop and, niggles aside, it will be a superb workhorse for years to come. **TIM DANTON**

## SPECIFICATIONS

12-core/24-thread AMD Ryzen AI 9 HX 370 processor ● 8GB Nvidia GeForce RTX 4070 graphics ● 64GB LPDDR5X RAM ● 16in 60Hz OLED touchscreen, 3,840 x 2,400 resolution ● 2TB M.2 PCI-E Gen4 SSD ● Wi-Fi 7 ● Bluetooth 5.4 ● 1080p IR webcam ● USB-C 4 ● USB-C 3.2 Gen 2 ● 2x USB-A 3.2 Gen 2 ● HDMI 2.1 ● 3.5mm combo jack ● SD Express 7 card reader ● 90Wh battery ● Windows 11 Home ● Asus Pen 2 ● 355 x 247 x 14.9-17.3mm (WDH) ● 1.9kg ● 1yr C&R warranty ● part code 90NB1421-M00180



## Asus Zenbook S 16 (UM5606)

The ceramic-style lid makes this slim laptop stand out, but we question whether it's worth the high price

SCORE ★★★★★

PRICE £1,417 (£1,700 inc VAT)  
from [uk.store.asus.com](https://uk.store.asus.com)

While Asus designed the new ProArt laptops (see p50) to extract every last ounce of juice from AMD's Ryzen AI 9 HX 370 processor, the Zenbook S 16 takes a different approach. Yes, this super-slim 16in laptop is fast, but with far less room in its 12.9mm-thick chassis for cooling it's not the best choice for those with demanding workloads.

This was made abundantly clear in Cinebench 2024, which lasts at least ten minutes per test. Where the ProArt systems were hitting around 1,200 in the multicore section, the best score I extracted from the Zenbook S 16 was 915. It was a similar story in Geekbench 6's multicore test, with a 13,239 result paling in comparison to the 15,000+ of its siblings.

If the fans and cooling system can't take full advantage of the 12-core CPU, then there's an argument that you're wasting your money – that you're better off buying the version of the Zenbook S 16 with a ten-core HX 365 inside. However, Asus kiboshes that argument with its pricing. The HX 365 model costs £100 less, but you also drop from 32GB of RAM to 24GB and the graphics are the lesser Radeon 880M unit rather than the 890M. I haven't tested any laptops that use 880M graphics yet, but the gap between their specs suggest it will be around 20% slower.

One of this laptop's most attractive features is its gaming capability, so I don't think that's a sacrifice worth making for £100 when you're already spending this much. At 120op for *Dirt 5*

and 1080p for the rest, I saw extremely playable frame rates at Low settings in my test suite of games: around 50fps in *Dirt 5*, *Cyberpunk 2077* and *Shadow of the Tomb Raider*. And it stayed above 30fps in the latter two games when I switched to High settings.

To take advantage of the superb OLED screen's 2,880 x 1,800 native resolution and 120Hz refresh rate you'll need to switch to less demanding games. The best result I saw was in *Cyberpunk 2077*, which squeezed out 33fps at Low.

The good news is that even at lower resolutions you'll enjoy excellent colour coverage – 100% of the DCI-P3 gamut – which gives games genuine punch. You don't get insane levels of brightness, peaking at

380cd/m<sup>2</sup> in our SDR tests, but OLED panels' perfect contrast mean it's easy to read in every light condition other than bright sunlight. It's a glossy panel, too, so expect reflections. With VESA's DisplayHDR True Black 500 certification it should be no surprise that films look fantastic on this panel, and Asus backs this up with a fine pair of speakers mounted above the keyboard. Treble dominates over bass, but I was happy listening to music in the background while working.

There's only 1.1mm of travel on the keys compared to 1.7mm for the ProArt laptops, and a less crisp action, but it's quiet even if you thump the keys when typing. Frequent cursor arrow users won't love the half-height keys, or the function doubling with Home, End, PgUp and PgDn, while others who detest single-height Return

**ABOVE** The Zenbook S 16 offers a sensible mix of screen size, power and portability

**"With far less room in its 12.9mm-thick chassis for cooling it's not the best choice for those with demanding workloads"**

**LEFT** A striking ceramic effect lid gives the laptop a unique look

**BELOW** The Zenbook's giant touchpad compensates for the imperfect keyboard

slimness to enhance this laptop's striking design. Its best feature of all is its ceramic effect lid, complete with geometric patterns. It won't be to everyone's taste, but I guarantee you've never seen a laptop like this before.

Despite that slender chassis there's still room for a 78Wh battery inside, and I wasn't surprised to see the

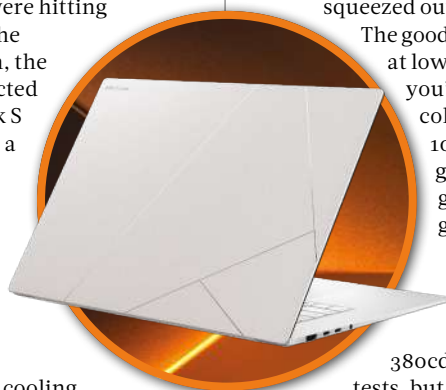
Zenbook S 16 outlast both ProArt laptops in PCMark's rundown tests. It lasted 12hrs 16mins in the undemanding Modern Office test and 13hrs 24mins when playing back a 1080p video, and

with a 1.5kg weight the Zenbook S 16 offers a sensible mix of screen size, power and portability. Asus also ticks off all the other features I'd expect from a premium laptop in 2024, with a high-quality 1080p webcam, Wi-Fi 7 and Bluetooth 5.4.

It falls a fraction short of an award due to the price and the sheer amount of competition in this sector, as evidenced by the LG gram Pro (see p60). I also feel that if you're going to spend this much for a laptop with a top-end CPU such as the Ryzen AI 9 HX 370 inside then you want a machine that makes the most of it. However, it's still far faster than most laptops and packed with quality, so if you're after a 16in workhorse then it passes muster. **TIM DANTON**

### SPECIFICATIONS

12-core/24-thread AMD Ryzen AI 9 HX 370 processor • AMD Radeon 890M graphics • 32GB LPDDR5X RAM • 16in 120Hz OLED touchscreen, 2,880 x 1,800 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2x USB-C 4 • USB-A 3.2 Gen 2 • HDMI 2.1 • 3.5mm combo jack • SD card reader • 78Wh battery • Windows 11 Home • 354 x 243 x 11.9-12.9mm (WDH) • 1.5kg • 1yr C&R warranty • part code, 90NB13M4-M003UO



### BATTERY LIFE





# How we test

## Laptops and PCs

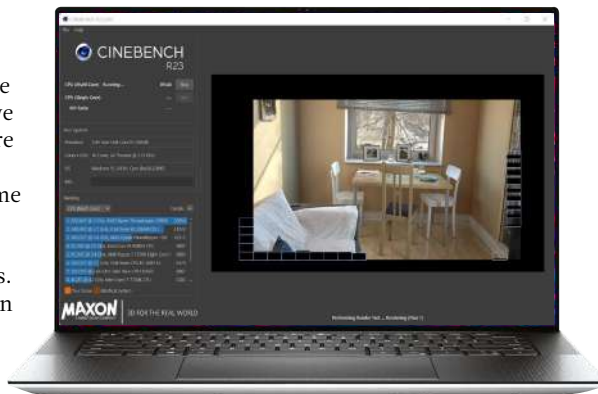
We run a selection of benchmarks on all the PCs and laptops we test. Where possible, we use a cross-platform test so we can compare Windows and macOS machines, which is where both Geekbench and Cinebench come into play. Both push the CPU to its limit, exposing how well cooled a system is.

We run extra tests for Windows systems.

We use PCMark 10 to benchmark systems in office tasks, content creation and basic tasks such as web browsing and video calls. We also run 3DMark Time Spy and *Shadow of the Tomb Raider* as a

minimum. We test laptops and PCs that include discrete graphics with a range of games, such as *Metro Exodus Enhanced* and *Dirt 5*.

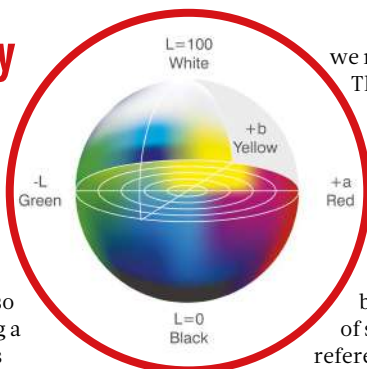
For laptops, we test battery life with Wi-Fi on and the screen brightness set to 150cd/m<sup>2</sup>. We fully charge the laptops and drain them until they reach 5%. For Windows laptops, we will use a mix of PCMark 10's light-use and video-based tests, or a web surfing benchmark where a laptop automatically visits sites until the battery dies. We also use this test for MacBook.



**ABOVE** We put PCs and laptops through our intensive set of benchmarks

## Screen quality

In each laptop, phone, tablet and monitor review, you'll see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a X-Rite Display 11 Plus colorimeter. We measure maximum brightness, colour accuracy and (for monitors)



we run Geekbench 6. This is a good test of the processor and memory in particular, and include both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run 3DMark Wild Life test to give a measure of gaming performance.

We test tablet battery life by playing a full-screen video until the battery runs out with the device. To simplify the test, we use Airplane mode. We set the brightness to as close to 150cd/m<sup>2</sup> as we can get in the device's settings. We also put phones through a set of real-world and labs-based tests.



**LEFT** We use a Display 11 colorimeter to measure sRGB gamut coverage and Delta E

**BELOW** We play a video with the screen set to 150cd/m<sup>2</sup> to test battery life



consistency – there may be a difference in, say, brightness from the middle and the edges of the panel. We also measure Delta E, which is a guide to how accurately panels display colours. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.

## Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we review. First,

| GEEKBENCH 6 (SINGLE CORE)                               |       |
|---------------------------------------------------------|-------|
| Google Pixel 8a<br>Tensor T3, Mali-G715s graphics       | 1,581 |
| Google Pixel 7a<br>Tensor T2, Mali-G710 graphics        | 1,408 |
| Samsung Galaxy A55<br>Exynos 1480, Xclipse 530 graphics | 1,161 |
| Samsung Galaxy A35<br>Exynos 1380, Mali-G68 graphics    | 1,015 |
| Samsung Galaxy A54<br>Exynos 1380, Mali-G68 graphics    | 996   |

HIGHER IS BETTER

## What our awards mean



### Recommended

This, quite simply, is a product we recommend you buy – if it meets your needs.



### A-List

The best buy in its category right now. The product will also feature on our A-List, starting on p14. It's updated each month.



### Labs Winner

Each month we run a group test, or Labs. This product has managed to beat all others to top position.

## Tinyurl.com links

Throughout the magazine you'll see tinyurl.com shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we may have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper than we will use that instead.

## Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change, especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

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## PCSpecialist 14 Lafité AI AMD

No frills and a terrible webcam, but this is one of the most affordable AI laptops around

SCORE ★★★★★

PRICE £624 (£749 inc VAT) from [pcspecialist.co.uk/reviews](https://pcspecialist.co.uk/reviews)

Dell's Inspiron 14 Plus (see p59) is currently the cheapest Copilot+ PC around, but if that's still too much and your heart is set on an AI PC, then the PCSpecialist Lafité AI AMD may be the answer.

Rather than featuring one of AMD's new Ryzen AI 300 series chips (see p48), PCSpecialist saves a chunk of cash by opting for last year's AI hotshot, the Ryzen 8845HS. Its NPU offers 16 TOPS compared to the 55 TOPS of the Ryzen AI 370 HX in the trio of Asus laptops on review this month, which means no Recall or Cocreator built into Windows, but you can take advantage of third-party software enhanced for NPUs. So far, that mainly means video- and photo-editing software (think removing background noise), plus blurring effects in video calls.

You're also buying an eight-core, 16-thread processor, and one that typically stands up well compared to Intel's Core Ultra 7 155H. You can see that in the single-core performance in Geekbench 6, with a result of 2,532 above the 2,349 of the LG gram Pro (see p60). I saw the same in Cinebench 2024, where the Lafité scored 105 to 99 of the LG, and it also performed in

the multicore section: 871 versus 660. It was only in Geekbench 6's multicore test that PCSpecialist's machine came second, with 9,875 to the gram Pro's 12,646.

PCSpecialist provides 16GB of RAM, leaving one SODIMM socket free. That hampers gaming performance, which you can see in the Lafité's 1,749 return in 3DMark Time Spy – the Radeon 780M graphics here typically return a score closer to 3,000 – and our gaming benchmarks. At 1080p Low settings, the Lafité returned averages

of 28fps in *Shadow of the Tomb Raider* and *Cyberpunk 2077*, and 36fps in *Dirt 5*. These frame rates should jump by around 50% if you install a second SODIMM.

It's easy to do this yourself as just a few crosshead screws keep the base in place. You can also replace the 512GB SSD, a budget SolidIGM drive that offers fast 3,515MB/sec sequential reads but 1,606MB/sec writes.

The budget again shows in the chassis, which is made of metal but doesn't exude the class of its big-name rivals. It's also a porky 18.5mm thick and weighs 1.4kg. The 100W power supply is similarly chunky and adds 330g of weight, but it does its job quickly: the Lafité went from empty to 93% in an hour. Battery life is strong for such an affordable laptop, lasting for 12hrs 2mins in our light-use test, but that's an area where Qualcomm-powered laptops are far superior.

You can't expect a top-grade panel at this price, but PCSpecialist makes a much better pick than Dell with the Inspiron. Not only does this IPS panel produce great whites, it covers 99% of the sRGB gamut with excellent accuracy (an average Delta E of 0.29), and brightness peaks at a respectable

375cd/m<sup>2</sup>. Add a 120Hz refresh rate and pin-sharp 2,880 x 1,800 resolution and it's an undoubted highlight. The speakers are again good for the price.

I'm less enamoured by the keyboard, which feels like someone forgot to add the springs, but it's functional, includes a backlight and suffers from no obvious layout issues. The touchpad is similarly basic, and the buttons too "clicky" for my liking, but again I guide your eyes to this laptop's asking price. I'm less

forgiving about the woeful webcam, with a fuzzy image I'd be embarrassed to use on a call. At least it supports Windows Hello.

While I would like more than one USB-C port, which is needed for charging, it is at least USB-C 4. And there are three USB-A ports, two of which support 10Gbits/sec transfers. A 3.5mm jack and full-size SD card slot complete the hardware, with Wi-Fi 6E and Bluetooth 5.2 covering the wireless side.

I have my criticisms, but the price is simply exceptional. Add in the three-year warranty – even allowing that parts are only covered for the first year – and it's impossible to argue with. I would immediately buy and fit a matching 16GB

Corsair DDR5-4800 SODIMM to give gaming a boost, but otherwise this is a great laptop for those who prioritise specs over slick design. **TIM DANTON**

**ABOVE** The Lafité AI AMD is exceptionally good value

**"I have my criticisms, but the price is simply exceptional. Add in the three-year warranty and it's impossible to argue with"**

**LEFT** The keyboard and touchpad are basic but functional

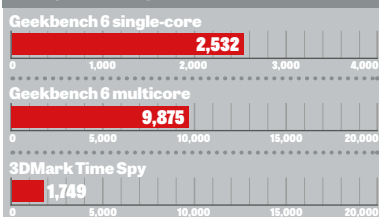
### SPECIFICATIONS

8-core/16-thread AMD Ryzen 8845HS processor • integrated AMD Radeon 780M graphics • 16GB Corsair DDR5-4800 RAM • 14in non-touch IPS display, 120Hz, 2,880 x 1,800 resolution • 512GB M.2 Gen4 SSD • Wi-Fi 6E • Bluetooth 5.2 • 1080p IR webcam • USB-C 4 • 2 x USB-A 3.2 Gen 2 • USB-A 3.2 Gen 1 • 3.5mm combo jack • 80Wh battery • Windows 11 Home • 312 x 220 x 18.5mm (WDH) • 1.4kg • 3yr warranty (6 months C&R, 1yr parts, 3yr labour)

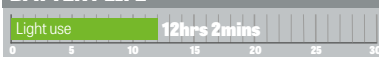
**BELOW** The chunky chassis is made of metal but doesn't exude class



### BENCHMARKS



### BATTERY LIFE





## Lenovo Yoga Slim 7x (Gen 9)

An attractively priced Snapdragon Copilot+ PC with strong battery life and a striking 14.5in OLED screen

SCORE ★★★★★

PRICE As reviewed, £1,125  
(£1,350 inc VAT) from [lenovo.com](https://www.lenovo.com)

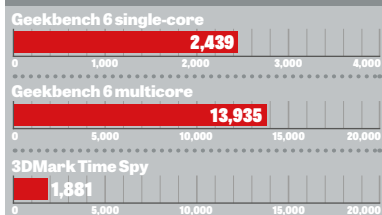
Many Copilot+ PCs feel as if they were built for Intel chips before being retro-fitted with Qualcomm's Snapdragon technology. Not so the Lenovo Yoga Slim 7x. It more than lives up to its name, measuring 12.9mm thick compared to 14.9mm for the Intel-based Yoga Slim 7, and the only surprise is that it weighs 1.3kg. This is reflected in the sturdiness of its aluminium alloy chassis, but if Lenovo had chosen magnesium alloy it would have been lighter – and more expensive.

Where the Yoga Slim 7x has followed the same trend as other Copilot+ PCs is that it has already dropped in price. We print the RRP above, but at the time of going to press you could buy the specification on test for £1,200 inc VAT. Too much? The cheapest model currently costs £1,049, with a 512GB SSD and 16GB of RAM rather than the 1TB/32GB combo in our unit.

My one word of warning is that you should choose the amount of memory wisely, as you can't replace or upgrade this later. In fact, the only user-replaceable items are the M.2 2242 SSD and 70Wh battery.

The latter powered this laptop for around 16 hours under light use, which is a great achievement when you consider the demands of its 14.5in OLED panel. This is incredibly sharp thanks to a 2,944 x 1,840 resolution, and it peaked at a superb 508cd/m<sup>2</sup> in our tests; that's with SDR content, but its VESA True Black 600 certification

### BENCHMARKS



### BATTERY LIFE



shows it can hit 600cd/m<sup>2</sup> when displaying HDR content. It also covers 100% of the DCI-P3 gamut with an average Delta E of 0.29, so effectively perfect accuracy. It shows that you don't need to compromise panel quality even when paying around £1,000.

Not that Lenovo gets everything right. I'd like Lenovo's Vantage software to offer more control over colour temperature (at the panel's native 6205K whites look cold) and colour gamuts, while the glossy finish is predictably reflective. But I'm being fussy. Overall, this is an exceptional panel for a laptop this affordable.

Lenovo often sacrifices quality on its non-ThinkPad keyboards, but not here. There's a firm feel to each key press, excellent backlighting and plenty of attention to detail: subtly concave keys, a double-height Enter key, grouped function keys and full-size left and right cursors. The glass touchpad, which measures 135 x 80mm, is again top-quality, and a great complement to the touchscreen for navigation.

It's also good to see a clearly labelled privacy key for the webcam, which is predictably excellent: I haven't seen a duff one yet on a Copilot+ PC. The IR camera supports Windows Hello, which worked perfectly throughout my tests, but there's no fingerprint reader and the power switch sits awkwardly on the side; I prefer them on or adjacent to the keyboard.

The other usability challenge concerns ports. With such a slim chassis, there's no room for USB-A, so you're reliant on three USB-C ports and the bundled

USB-C adapter. Finished in white rather than blue to match the Slim 7x's anodised finish, this adds a 3.5mm combo jack, one USB-A 3.2 Gen 2 port, HDMI and, weirdly, a VGA output. An RJ45 port would have made much more sense, but the inclusion of both Wi-Fi 7 and Bluetooth 5.3 ease any connectivity concerns.

Despite the flexible Yoga name, this isn't a convertible,

so you don't get the handy tent mode for watching films or sharing presentations. What you do get is a powerful sound system, featuring two 2W woofers along with the 2W tweeters. I was more than happy to listen to music on this laptop, with complicated Björk arrangements coming through with clarity – and drums that often go missing on lesser speakers were present here.

I won't go into much depth on performance. The Yoga Slim 7x uses the X1E-78-100 SoC, which is a mid-range Snapdragon X Elite chip. It's snappy during day-to-day use and also flies through benchmarks, with

excellent multicore returns in Geekbench 6 and Cinebench 2024 (13,935 and 1,044 respectively). Its single-core power can't match the X1E-80 or X1E-84, but it held its own against the

Dell XPS 13 (see p58) in *Shadow of the Tomb Raider*, with 30fps at 1080p Low settings. However, if you're buying a Copilot+ PC for gaming then you'll probably be disappointed anyway.

When you consider the price – I'm assuming the lower figures hold for the foreseeable future – I don't think you'll find a better-value Copilot+ PC. Unless you're constantly using USB-A ports on the move, this is my pick of the "new generation" of AI computers so far. **TIM DANTON**

ABOVE The Yoga Slim 7x is blessed with a fantastic OLED panel

**"When you consider the price, I don't think you'll find a better-value Copilot+ PC. This is my pick of the new AI computers so far"**

BELOW The extremely slim chassis has no room for USB-A ports



### SPECIFICATIONS

12-core Qualcomm Snapdragon X1E-78-100 SoC • Qualcomm Adreno graphics • 32GB LPDDR5X RAM • 14.5in 90Hz OLED touchscreen, 2,994 x 1,840 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.3 • 1080p IR webcam • 3x USB-C 4 • 3.5mm combo jack • 70Wh battery • Windows 11 Home • 325 x 225 x 12.9mm (WDH) • 1.3kg • Lenovo USB-C 4-in-1 hub • 1yr C&R warranty



## Dell XPS 13 (Snapdragon)

The slickest and most customisable Copilot+ PC yet, but the screen is poor and competition tough

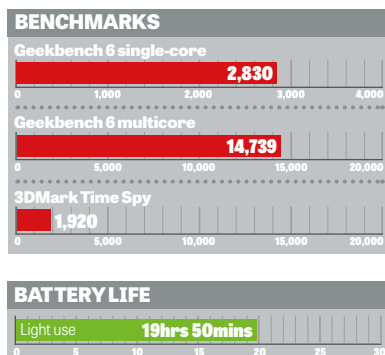
**SCORE** ★★★★★

**PRICE** As reviewed, £1,041 (£1,249 inc VAT) from [dell.co.uk](https://www.dell.co.uk)

**W**hile Dell's Inspiron brand focuses on value, the XPS range is all about luxury. That should be immediately obvious from the photo, with the sleek and chic XPS 13 designed to turn heads. There's no visible touchpad, the function keys light up, and the edge-to-edge keyboard and super-slim bezels add yet more visual flair.

It's also highly configurable. Most Copilot+ PCs come in a handful of configurations, but here you can choose between 16GB, 32GB and 64GB of RAM; 512GB, 1TB or 2TB of storage; and from a trio of screens, two supporting touch (one OLED, one IPS) and one not. You can even choose between graphite and platinum colour finishes.

Dell chose to send us the platinum version – with an attractive metallic, almost white finish – complete with 16GB of RAM, 512GB of storage and the most basic non-touch panel. It's the cheapest configuration, with a list price of £1,249 inc VAT, but as is a custom theme this month you can currently enjoy a big discount: £1,099 as we went to press. However, if you wanted to match the specification of Lenovo's Yoga Slim 7x (see p57) – so 32GB of RAM, a 1TB SSD and a 3K OLED panel –



you'd have to pay £1,579, down from its £1,849 RRP.

Sadly for Dell, the supplied IPS panel doesn't compare well to others. I can live with a 1,920 x 1,200 resolution, as text remains sharp across its 13.5in diagonal, but I expect better quality from a Dell XPS laptop. It only covers 69% of the DCI-P3 colour space and whites are impure. The literal bright spot is its 523cd/m<sup>2</sup> peak luminance, and colour accuracy is excellent, but I never enjoyed using it.

Then we come to the keyboard, which is divisive. Perhaps after a few weeks of use I would stop making stupid typing errors, but due to its off-centre design (for no good reason) I found my fingers kept hitting the wrong keys. I had less of an issue with the invisible haptic touchpad, with my only misfires being when I tried to drag and drop folders.

Not everyone will be a fan of only having two USB-C ports, either, with one on each side. At a desk, it's a non-issue thanks to the affordability of USB-C port replicators and docking monitors, but there will be times when you're stuck with a USB-A thumb drive and nowhere to put it.

One of those USB ports is needed for the compact USB-C charger, but if there's one area where the new XPS 13 excels it's battery life. It lasted for a lung-busting 19hrs 50mins in our light-use test, and I wouldn't think twice about shoving this slim,

compact 1.2kg laptop into a bag. When it does come time to recharge, you won't be kept waiting: zero to 88% in an hour is excellent.

The XPS 13's performance throughout the rest of our benchmarks was predictable, with superb results in every area other than gaming. Opening up the base – held in place by six tiny Torx T5 screws – reveals a pair of fans to keep air flowing, all dispelled by a discreet vent at the rear. In general use the XPS 13 is almost silent, but you can choose the Ultra Performance option in the MyDell

Console if you need to push it. It's further

helped by a speedy SSD

that returned 5,027MB/sec sequential reads and 4,391MB/sec writes.

Dell earns yet more bonus points for the webcam, which produces vivid and detailed images, and the microphone setup is well tuned to pick up your voice even in the hubbub of cafés. My sole audio criticism is for the speakers, with trebles dominating, but that feels like a tuning issue as their quality is top-notch otherwise. Bass is terrific for such a tiny laptop.

With a solid one-year warranty that's easy to upgrade, the XPS 13 leaves me in a quandary. On one hand, £1,099 for such a well-designed, high-quality laptop

is a bargain (assuming the discount still applies); on the other, the supplied IPS panel doesn't do the rest of this laptop justice. But switching to the OLED panel immediately adds £300, the IPS touchscreen a barely credible £450.

All of which means that I can't recommend the XPS 13, especially when it has such strong competition from the Lenovo Yoga Slim 7x. **TIM DANTON**

### SPECIFICATIONS

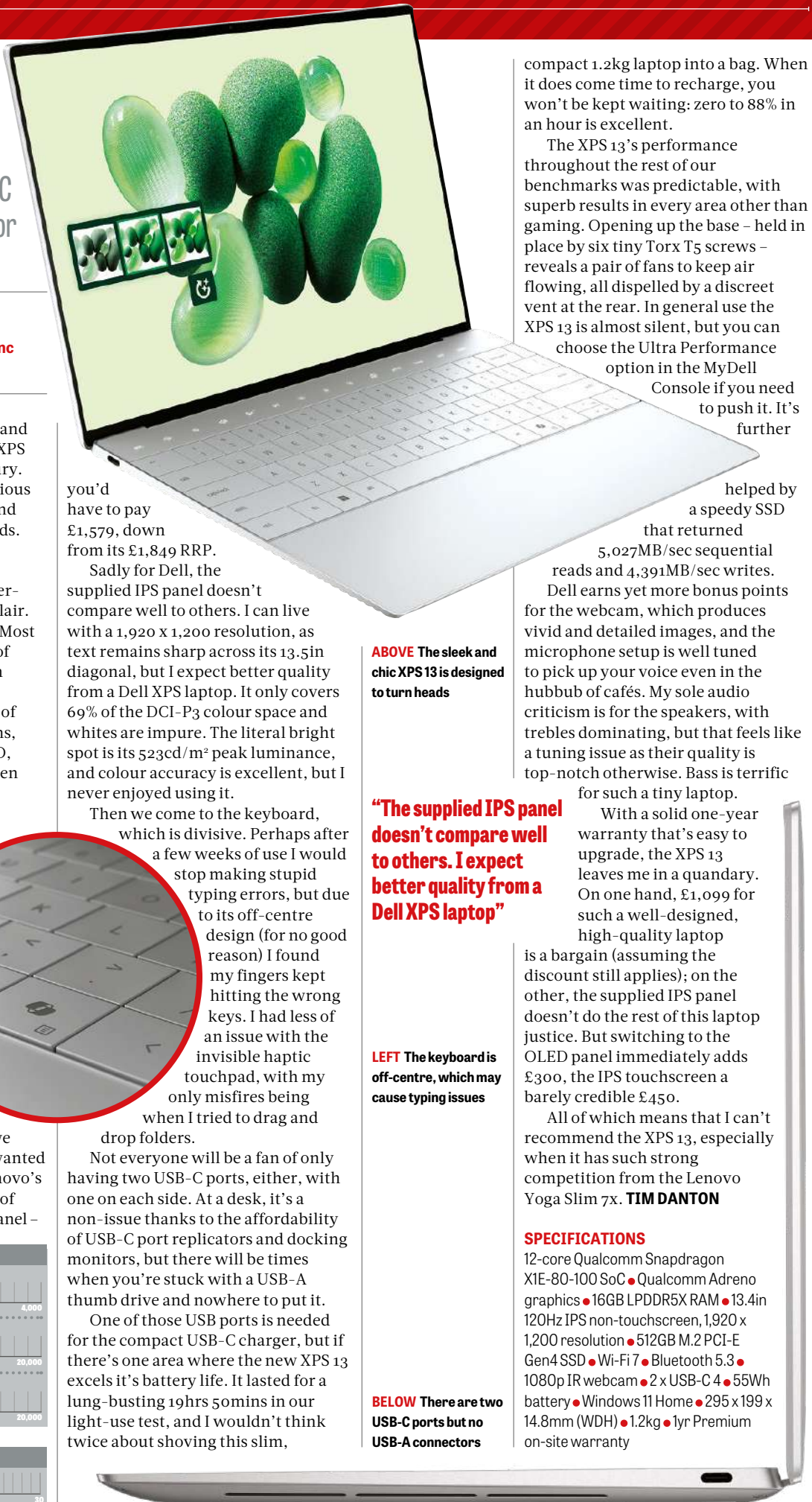
12-core Qualcomm Snapdragon X1E-80-100 SoC • Qualcomm Adreno graphics • 16GB LPDDR5X RAM • 13.4in 120Hz IPS non-touchscreen, 1,920 x 1,200 resolution • 512GB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.3 • 1080p IR webcam • 2 x USB-C 4 • 55Wh battery • Windows 11 Home • 295 x 199 x 14.8mm (WDH) • 1.2kg • 1yr Premium on-site warranty

**ABOVE** The sleek and chic XPS 13 is designed to turn heads

**"The supplied IPS panel doesn't compare well to others. I expect better quality from a Dell XPS laptop"**

**LEFT** The keyboard is off-centre, which may cause typing issues

**BELOW** There are two USB-C ports but no USB-A connectors





# Dell Inspiron 14 Plus (Snapdragon)

A fine debut for Qualcomm's Snapdragon Plus chip, and great speakers, but what a shame about the screen

SCORE

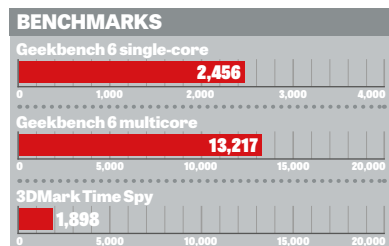
PRICE As reviewed, £874 (£1,049 inc VAT) from dell.co.uk

The Inspiron 14 Plus marks two interrelated firsts: it's the first Copilot+ PC to include a Snapdragon X Plus chip rather than X Elite, and the first to duck under the £1,000 mark. If Dell had sent us this version of the 14 Plus with a 512GB SSD rather than 1TB then that's the price you would see above.

That's because it uses the X1P-64-100 chip, with "P" standing for Plus. It has ten cores to the Elite's 12, slower clock speeds and slower graphics. In single-core tasks, it's almost identical to the X1E-78-100 in the Lenovo Yoga Slim 7x (see p57), but switch to core-intensive applications and the Yoga pulls ahead – particularly in Cinebench 2024, with 1,044 versus 683.

Don't imagine that this laptop is slow, however, because Windows is just as nippy as with all the other Copilot+ PCs I've tested. As ever, gaming is its Achilles' heel, with paltry frame rates – only breaking 30fps in the Lowest settings of *Shadow of the Tomb Raider* and *Dirt 5* at 1200p – and spotty compatibility.

Battery life is once again phenomenal, lasting for 15hrs 57mins in PCMark's light-use Modern Office test and 24hrs 7mins when left idling. And it charged up to 50% from empty in half an hour, which is good going from a standard-issue 65W Dell charger. Where it loses out compared to the XPS 13 and Yoga Slim is for portability, weighing 1.4kg, while the chassis measures a comparatively chunky 16.9mm at its thickest. This,



alongside the dull grey silver design, makes it far less visually attractive than its Copilot+ PC rivals.

Dell's most visible cost-cutting measure is the screen. There's nothing wrong with its 2,560 x 1,600 resolution, but the whites are clearly off and no fiddling with colour temperature apps is going to fix this. I found the best option was to push brightness to its 485cd/m2 peak, which lessened the effect. This panel also covers only 70% of the DCI-P3 gamut, so it isn't a laptop for photographers or film lovers.

I expected the speakers to be similarly limp, but they proved the surprise package. Not only do they go loud, but there's audible bass (two woofers help) and clear vocals. The speakers sit either side of the keyboard, which is well laid out and benefits from large keys. There isn't much cushioning to their action, and the backplate bends in the middle if you bash hard, but that's the only sign of cost-cutting. Unless you count a non-glass touchpad, but it's still responsive.

A fingerprint sensor accompanies the IR webcam, and this is a match for more expensive laptops, with crisp detail, excellent colours and all the fancy effects I've come to expect with AI PCs (the portrait blur is arguably the best).

Dell takes a pragmatic approach to ports, with twin USB-C 4 ports on the left alongside a microSD card slot, while a slowish USB-A 3.2 Gen 1 port and 3.5mm combo

**ABOVE** The Inspiron 14 Plus is a fine laptop marred by its poor-quality display

**"Dell's most visible cost-cutting measure is to the screen. Its whites are clearly off and no fiddling is going to fix this"**



**ABOVE** The dull grey design is less visually attractive than most Copilot+ PC rivals

**BELOW** Twin USB-C 4 ports and a microSD card slot sit on the left

jack sit on the right. Nor are you left behind for wireless, with Wi-Fi 7 and Bluetooth 5.4 both present.

Upgrades are limited. The 16GB of memory is integrated, while any replacement SSD must comply with the M.2 2230 form factor – don't think this equates to slow, however, as the Inspiron's 1TB drive hit 6,191MB/sec sequential reads and 4,824MB/sec writes. You can also replace the M.2 Wi-Fi card and 54Wh battery.

Where Dell knocks things out of the park compared to rivals is through its warranty, with three years of Dell Premium Support – which covers on-site repair if suitable, but more impressively covers hardware faults throughout. You could argue that this alone adds £200 of value to this laptop.

All of which leaves me shaking my head despairingly at whoever decided to fit such a mediocre panel. Every other budget decision makes sense, but not the display – the item you'll be looking at every day. So, it's harsh, but this is why I'm only giving Dell three stars for the Inspiron. **TIM DANTON**

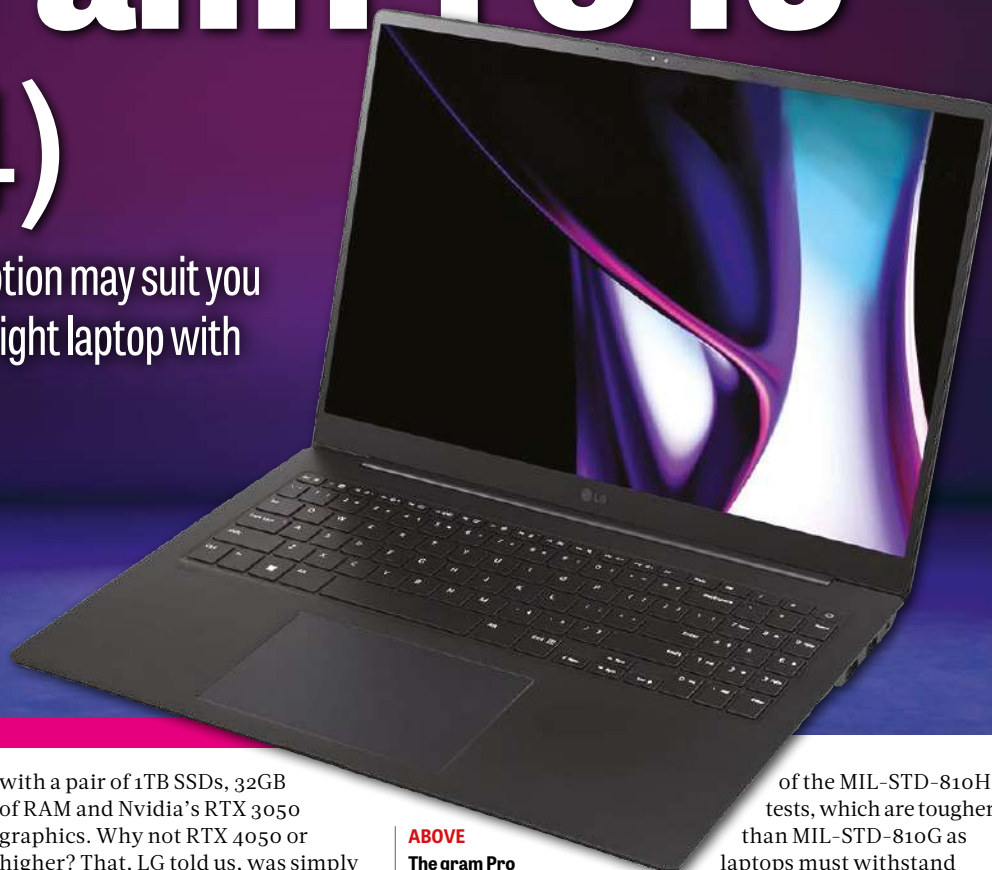
## SPECIFICATIONS

10-core Qualcomm Snapdragon X1P-64-100 SoC • Qualcomm Adreno graphics • 16GB LPDDR5X RAM • 14in 120Hz IPS touchscreen, 2,560 x 1,600 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2x USB-C 4 • USB-A 3.2 Gen 1 • 3.5mm combo jack • microSD card slot • 54Wh battery • Windows 11 Home • 314 x 224 x 16.9mm (WDH) • 1.4kg • 3yr Premium on-site warranty



# LG gram Pro 16 (2024)

The cheaper non-Nvidia option may suit you better, but this is a super-light laptop with a fine 16in OLED screen



**SCORE** ★★★★★

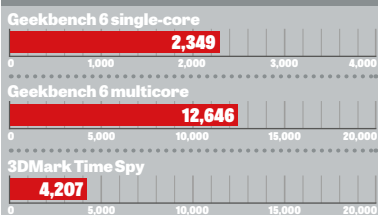
**PRICE** £1,999 (£2,399 inc VAT)  
from [currys.co.uk](https://www.currys.co.uk)

**L**G takes a straightforward approach with its gram laptops. Every single one is slim and light, and with each passing year we see upgrades in lock-step with Intel's offerings. This year, that means Core Ultra chips, and every gram Pro model – the Pro is LG's most premium version of the gram – will ship with Intel's Core Ultra 7 155H processor.

Your big decision is whether to opt for a discrete Nvidia graphics chip rather than relying on Intel's Arc graphics. The former adds almost 100g, but the chassis is identical.

The gram Pro comes with different RAM, storage and screen options (there's even a 17in version), and our test model sits at the top of the range

## BENCHMARKS



## BATTERY LIFE



with a pair of 1TB SSDs, 32GB of RAM and Nvidia's RTX 3050 graphics. Why not RTX 4050 or higher? That, LG told us, was simply down to size: the current iteration of the RTX 4050 is too thick and would need a chunkier chassis.

## Going inside

The cooling system has also been upgraded this year, with the promise of a very specific 26% improvement gained by splitting the two fans to improve airflow. You can see this for yourself by removing the four rubber bumper feet that cover the crosshead screws and then unclipping the metal bottom cover.

You'll then discover that little is upgradable. The pair of M.2 2280 SSDs are the main exception, and it's relatively easy to remove and replace the 90Wh battery too, but the RAM and Wi-Fi are both integrated onto the motherboard, so let's hope they don't go wrong.

It's disappointing that LG doesn't upgrade its consumer-orientated one-year return-to-base warranty with these Pro models, but if you buy from Currys you can always opt for its "Care & Repair" cover. This doesn't include accidental damage, but £300 gives you on-site repairs for three years. Or you can simply hope that it survives the bashes of commuting life, and there are reasons to be optimistic. LG claims the gram Pro has passed seven

**ABOVE**  
The gram Pro benefits from the latest Intel refresh

of the MIL-STD-810H tests, which are tougher than MIL-STD-810G as laptops must withstand multiple drops onto a hard floor from waist height.

## Sleek design

This level of build quality shines through when you pick up the gram Pro. The chassis is made from magnesium alloy, with a black coating for extra style, and the only area that feels susceptible to bashes is the lid. This is flexible,

but that isn't always a bad thing as it absorbs knocks.

Considering the powerful components inside, it's also remarkable that LG keeps the gram Pro

**"The level of build quality shines through when you pick up the gram Pro. The chassis is made from magnesium alloy"**

down to a maximum 14.4mm thickness (it tapers down to 13mm at the front). Combine that with a 1.3kg weight and this is one of the lightest 16in laptops you can buy. I wish LG would follow Huawei and Samsung's example and include a phone-style charger rather than the traditional "rat and tail" models, but the supplied 90W fast charger (which weighs 315g) lives up to its name: the gram Pro went from zero to 52% in 30 minutes and to 93% in an hour.

**BELOW** The gram Pro is a remarkably slim 13mm at the front





Battery life is great by last year's standards, lasting for around 12 hours in our light-use tests. That should be enough to power most people through a day's work, but I can't ignore the fact that Copilot+ PCs keep going for around five hours more.

## ■ Speed difference

What's more, they're faster in everyday tasks. Take the 16in Samsung Galaxy Book4 Edge (see issue 360, p53) as an example. That's based on Qualcomm's X1E-84-100 chip, and even with LG's excellent cooling – and after I switched on Performance mode for its fans – the Samsung was quicker in Geekbench 6: in the single-core section, it scored 2,897 to the LG's 2,349, with 15,819 versus 12,646 in multicore tests. The gulf was even bigger in Cinebench 2024, where LG returned 99 and 660 in the single-core and multicore tests respectively, while the Book4 Edge managed 125 and 981.

Qualcomm's chips have an even bigger advantage for AI inferencing power. Intel's chip offers up to 34 TOPS overall, while all the Snapdragon chips offer 45 TOPS via the NPU alone. This is why the LG gram Pro won't benefit from the AI features included in the latest Windows 11 update (see p26). Whether that matters is questionable. The LG will still offload video background blur effects to the NPU built into the Core Ultra, and most people can live without Cocreator and Recall.

Where the LG is far superior to the current crop of Copilot+ PCs is graphics performance, due to the RTX 3050 graphics. This is easily illustrated by its 4,207 return in 3DMark Time Spy, twice that of the fastest Qualcomm-powered laptop. That will show itself in any creative app that takes advantage of GPU acceleration, and of the CUDA platform in particular.

## ■ Games, games, games

Of course, it also means games are playable. The gram Pro kept *Shadow of the Tomb Raider* running smoothly at 1080p High settings with an average of 45fps, while the Book4 Edge stuttered to 25fps. I even saw a playable 41fps at the panel's native resolution, by dropping Quality settings to Low. *Cyberpunk 2077* only returned 34fps at 1080p High settings, but switching to Low boosted that to 51fps.

The other gaming advantage is compatibility – I've hit frequent problems with games on Qualcomm systems – but the

RTX 3050's 4GB of memory will hold you back. Even at 1080p, *Dirt 5* complained about a lack of video RAM when playing at High settings; no such problems at Low, though, where it romped to a 48fps average.

What if you choose a gram Pro without GeForce graphics? The Core Ultra 7 155H includes Intel's Arc accelerator, which is extremely capable. It scored 3,785 in 3DMark Time Spy and managed 33fps, 43fps and 52fps respectively in *Cyberpunk 2077*, *Dirt 5* and *Shadow of the Tomb Raider*. That was at 1080p and Low settings, though, so you're clearly buying a superior gaming machine if you choose the RTX 3050 version.

## ■ Big-screen advantage

Even at Low settings, the OLED panel ensured that all three of those games looked fantastic. It covers 100% of the DCI-P3 gamut with excellent colour accuracy (its average Delta E was 0.25 and at worst 0.72), while the glossy screen adds yet more punch. The downside is in environments where reflections abound, but a peak brightness of 419cd/m<sup>2</sup> means it remains visible even outdoors.

Anyone who regularly works on two windows side by side will appreciate having 2,880 x 1,800 pixels across a 16in diagonal, and whites look almost perfect, particularly at full brightness. It's also worth experimenting with the Display settings in LG's Smart Assistant app, with colour temperature options and a Reader Mode that applies a sepia effect. My hopes were briefly raised by a Professional Mode, supposedly extending the colour gamut, but this had no effect. One final note: there isn't a touchscreen option, which kept surprising me during testing when I tried tapping onscreen prompts.

Considering the chassis' generous width, LG makes a surprising number of keyboard compromises. There's a single-height Enter key, function doubling on the half-height cursor keys and a narrow left Shift key. A number pad also means your hands shift off-centre when typing, which can be irritating. What won't irritate anyone is the near-silent keypresses, nor the backlight that shines through the letters and makes them easy to see in darkness.

**"The OLED panel covers 100% of the DCI-P3 gamut with excellent colour accuracy, while the glossy screen adds yet more punch"**

## ■ Final touches

Where LG does win out is practicality. Two Thunderbolt/USB-C 4 ports sit on the left, alongside an HDMI port,

while a pair of USB-A ports keep the 3.5mm jack company on the right. It would have been good to see Wi-Fi 7 rather than 6E built in, and Bluetooth 5.4 rather than 5.3, but I doubt whether that will have a big impact on most buyers.

LG gets all the basics right. The

IR webcam produces good-quality images at 1080p, with AI-enhanced microphones to pick up your voice even in challenging situations. Its speakers also make a decent stab at creating a stereo sound stage, and although I found trebles dominated, this is still one of the better audio setups you'll hear, especially for such a slim laptop.

The big challenge for LG is its pricing, and the fact this spec was rapidly discounted from a list price of £2,399 inc VAT to less than £2,000 shows how fierce competition is. As we went to press, this exact spec costs £1,980 inc VAT from [lg.com](https://www.lg.com), and you can save a further 5% by signing up for LG's newsletter.

However, I advise most people to head to [currys.co.uk](https://www.currys.co.uk) and buy the version with Arc graphics, 16GB of RAM and a 1TB SSD for £1,599 (as we go to press, the RRP is £1,899). You'll lose frame rates, but it's even lighter and gives you money to pay for the upgraded warranty. **TIM DANTON**

## SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • 4GB GeForce RTX 3050 graphics • 32GB LPDDR5X RAM • 16in 120Hz OLED non-touch panel, 2,880 x 1,800 resolution • 2 x 1TB M.2 PCI-E Gen4 SSDs • Wi-Fi 6E • Bluetooth 5.3 • 1080p IR webcam • 2 x Thunderbolt/USB-C 4 • 2 x USB-A 3.2 Gen 1 • HDMI 2 • 3.5mm combo jack • 90Wh battery • Windows 11 Home • 258 x 252 x 13-14.4mm (WDH) • 1.3kg • 1yr RTB warranty • part code 16Z90SP-A.AD8BA1

**LEFT** Despite the slender chassis, there's room for two Thunderbolt ports



**ABOVE** The keyboard fails to make the most of the wide chassis





## Getac S510

The first rugged laptop we've tested with a Core Ultra chip, and it ticks all the other necessary boxes, too

SCORE ★★★★★

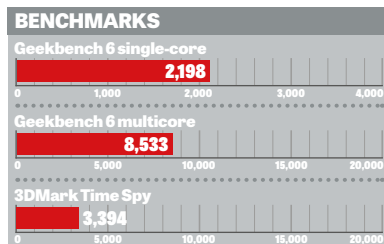
PRICE £3,995 (£4,794 inc VAT) from  
ultima-computers.co.uk

**Y**ou know that AI is everywhere when it sneaks its way into a rugged laptop. With the S510, Getac is jumping ahead of rivals such as Dell and Panasonic by not only offering Intel's Core Ultra chips but complementing them with optional GeForce GTX 1650 graphics.

This five-year-old chip still packs acceleration beyond integrated graphics, but not much beyond: the S510's 3,394 in 3DMark Time Spy is on a par with laptops using Intel's Arc graphics. However, any apps that take advantage of Nvidia's CUDA platform will be significantly faster.

The NPU built into the Core Ultra 7 165U vPro is modest, to the point where Intel doesn't even specify its standalone TOPS rating, merely "up to 34 TOPS" for the processor as a whole. It's hard to see this as a key selling point for this laptop, but there will be occasions where it will reduce the load on the CPU.

More importantly, Intel's recent chip ensures this is one of the fastest rugged laptops around, with its 8,533 in Geekbench 6 multicore a fraction faster than the 8,227 returned by the Panasonic Toughbook 55 MK3 (see issue 358, p58). That's despite the 55 MK3 having a Core i7-1370P with six P-cores, compared to two in the Ultra 7 165U. The Toughbook struck back in Cinebench R23, though, with a 10,319 result compared to 6,456.



The S510's literal big advantage over the Toughbook is its 15.6in display, compared to 14in for its rival, although they share the same 1,920 x 1,080 resolution. It covers a modest 55% of the sRGB gamut, but colours still look respectable and its whites are strong. It's also readable in all light conditions. Pumped up to its 1,093cd/m<sup>2</sup> maximum, and with a matte finish, I found it easy to read under bright sunlight.

An IP53 rating means the S510 can work in rainy conditions, but don't take the it on a Saharan holiday. That's despite a bumper-packed chassis and ports protected by thick covers. You can see the full list of ports that came with my review sample in the specifications listing, but more importantly it's customisable via modular units. If you need extra storage rather than a second battery, a removable drive is yet another option.

By including two 75Wh units, however, the S510 lasted for 15 hours under light use and almost 20 hours when playing back video. Those results aren't as remarkable as they used to be thanks to Snapdragon-powered Copilot+ PCs, but these batteries can be hot-swapped.

As is the norm for rugged laptops, Getac builds a carry handle into the design for easy portability, and it's also light at 2.4kg. It's bulky, though, stretching 39mm from top to bottom, while Getac's

**ABOVE** The recent Intel chip makes the S510 one of the fastest rugged laptops around



**LEFT** The resilient keyboard and rugged finish are well suited to tough environments

**"So long as an IP53 rating meets your needs, this is a top-quality and fast rugged laptop for demanding outdoor workers"**

**BELOW** A built-in handle makes the S510 easy to transport



keyboard designers could make more use of the 375mm width. Still, this is a keyboard built for resilience rather than touch typing, and the touchpad is a good size at 107 x 60mm. Physical mouse buttons sit below, which makes sense for gloved hands.

Two programmable buttons above the keyboard can be configured using the G-Manager app. This also gives you control over power profiles and lets you tune the touchscreen for gloves or rainy conditions.

The S510 is pretty up to date when it comes to Wi-Fi standards, with 6E and Bluetooth 5.3 on offer, while the 1080p webcam is capable. There's a slide-over privacy cover, too. Add an aggressive pair of speakers, built for volume in extreme environments rather than quality, and Getac ticks all the most important boxes.

If you don't need the GeForce graphics then you can save a considerable amount of money, with prices starting at £1,885 exc VAT for a Core Ultra 5 125U, 8GB of RAM and 256GB SSD. So long as an IP53 rating meets your needs, this is a top-quality and fast rugged laptop for demanding outdoor workers. **TIM DANTON**

### SPECIFICATIONS

12-core (2 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 165U vPro processor ● 4GB Nvidia GeForce GTX 1650 graphics ● 64GB DDR5-5600 RAM ● 15.6in 60Hz IPS touchscreen, 1,920 x 1,080 resolution ● 1TB M.2 Gen4 SSD ● IP53 rating ● Wi-Fi 6E ● Bluetooth 5.3 ● 1080p IR webcam ● 2x Thunderbolt/USB-C 4 ● 2x USB-A 3.2 Gen 2 ● smart card reader ● HDMI 2 ● D-SUB ● 2x 2.5Gb Ethernet ● 3.5mm jack ● serial port ● 2x 75Wh batteries ● Windows 11 Pro ● 375 x 277 x 39mm (WDH) ● 2.4kg ● 3yr bumper-to-bumper warranty ● part code, SU6D7GQ3SD2X



# Dell Latitude 9450 2-in-1

A no-compromise business convertible with quality in every area, making it worth the hefty price

SCORE ★★★★★

PRICE As reviewed, £1,986 (£2,383 inc VAT) from [dell.co.uk](https://www.dell.co.uk)

Dell has recently updated many of its Latitude business laptops with Intel's Core Ultra chips, and this is our first chance to look at one in the flesh. If you haven't checked out Latitudes for a while you might be struck by the dark grey matte chassis, a striking design that's a welcome move away from the light grey metal finish so common on business laptops.

Duck if one is thrown at you, however, as it's one dense, heavy machine. That's partly due to the robustness of the aluminium chassis, but also because convertibles are always meatier due to the hinge mechanism and the extra support this requires.

While you can customise the CPU (Ultra 5 135U or Ultra 7 165U), RAM (16GB, 32GB, 64GB) and storage (256GB, 512GB, 1TB), every version ships with the same screen. It's a 14in 2,560 x 1,600 IPS panel with a quoted peak of 500cd/m<sup>2</sup>, though I measured 489cd/m<sup>2</sup>. It covers 95% of the sRGB colour space with an average Delta E of 0.46, so near-perfect accuracy. With excellent white, you couldn't ask for more in a business laptop.

The keyboard is cut from the same cloth as the Dell XPS 13, with a pleasant feel to the keys. Again, though, I didn't enjoy the off-centre typing position. Then we

come to the touchpad. Not only is it gigantic, at 135mm wide and 90mm tall, but if you take part in a Teams or Zoom call then four buttons appear at the top. These allow you to

mute your mic, switch off the camera, jump to the chat function and share your screen.

I expected Dell to go all out on the webcam, too, but it's a typical

1080p unit and doesn't capture the level of detail you'll find on the best offerings. Where Dell wins is for the granular control over audio in the Dell Optimiser app, including the option to remove background noise. This app is also where you can enable advanced security features such as presence detection, while fingerprint and face recognition are both on offer, too.

During benchmarking, I activated Ultra Performance in Dell's software to give the system's Core Ultra 7 165U every opportunity. Two small fans keep the CPU cool, but even in this

**ABOVE** The latest Latitude laptops have been enhanced with Intel's Core Ultra chips

**LEFT** The laptop offers all the versatility of a convertible together with a superb screen

**"In day-to-day use, you'll have no issues with this laptop's performance. It should do sterling service for years"**

**BELOW** The keyboard has a pleasant feel, but is slightly off-centre

laptop's performance. It should do sterling service for years.

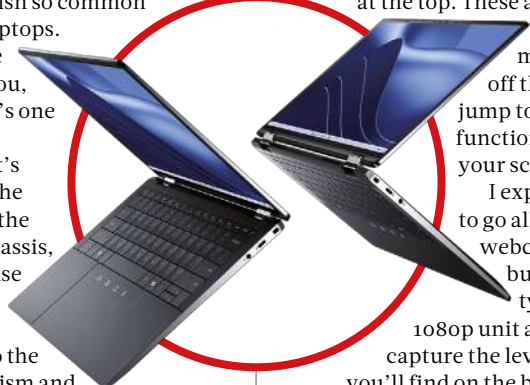
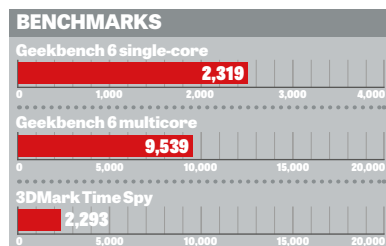
The first three of these are covered by the Dell ProSupport warranty that comes as standard, but this Latitude laptop is built with maintenance in mind. Standard crosshead screws keep the base secure, and the owner's manual provides a detailed guide on how to replace components, from the WAN antenna module to the speakers that sit either side of the keyboard. And those speakers are excellent, delivering a quality I'd expect from a consumer laptop rather than a business machine.

Some businesses may be similarly surprised by a laptop that only offers USB-C ports, with two on the left and a third on the right. Aside from a 3.5mm combo jack and security lock, that's your lot. Dell provides a tiny USB-C to USB-A dongle, and it's just about small enough to stay in a port permanently, but there's plenty of space for other ports on this 16.3mm-thick chassis so it's an oddly restrictive choice.

Perhaps Dell is looking to the future rather than the past, recognising that in five years USB-C ports will be the default, and that certainly reflects the progressive feel of the Latitude 9450 as a whole. Ports and price aside, I can't find anything to fault in this high-quality convertible. **TIM DANTON**

## SPECIFICATIONS

12-core (2 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 165U vPro processor • Intel Arc graphics • 32GB LPDDR5X-7467 RAM • 14in 60Hz IPS touchscreen, 2,560 x 1,600 resolution • 512GB M.2 Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 3 x Thunderbolt/USB-C 4 • 3.5mm combo jack • 60Wh battery • Windows 11 Pro • 311 x 215 x 14.9-16.3mm (WDH) • 1.5kg • 3yr ProSupport next-business-day on-site warranty



## MSI Cubi NUC 1M

Not the fastest mini PC, but a great choice for businesses thanks to its low power consumption and versatility

SCORE ★★★★★

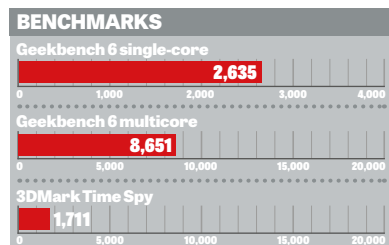
PRICE As reviewed, £641 (£769 inc VAT) from scan.co.uk

Last year, Intel stopped developing its popular NUC mini PCs, signing an agreement with Asus that it would “manufacture, sell and support the Next Unit of Compute (NUC) 10th to 13th generation systems product line, and to develop future NUC systems designs”. I assumed that meant Asus would have the monopoly on the NUC name, but not so: MSI has entered the fray with its Cubi NUC line, and assures me that more will follow in the coming months.

You can buy the Cubi NUC 1M as a barebones system, with the Core 3 100U version costing £349 inc VAT. Core 5 120U and Core 7 150U versions are available for £449 and £519 respectively (prices from scan.co.uk). Or you can buy Cubi NUCs as complete systems, supplied with RAM, SSDs and Windows 11 Pro. Here, I test the top-end version, with a Core 7 150U, 16GB of RAM and a 1TB SSD.

Arguably, this is a 14th gen NUC as Intel released the 150U earlier this year. However, Intel seems intent on adopting more confusing names for its chips with every release, and the 150U actually has much more in common with the 13th generation Core i5-1335U than the new Core Ultra line. It still uses the Raptor Lake architecture, includes two P-cores and eight E-cores, and there’s no NPU for local AI tasks.

Like all U series chips, the 150U is designed for maximum efficiency rather than all-out speed. When I pushed it to extremes, the Cubi’s fan kept at a low-pitched but audible hum, but its power consumption peaked at 61W (it’s 15W when idle). That compares to 101W from the Geekom A8 Mini PC (see issue 359, p62) when I tested it with an AMD Ryzen 9 8945HS.



While the Core 7 150U holds its own in single-core tasks, outperforming the Ryzen 9 8945HS in Geekbench 6 with a score of 2,635 versus 2,561, there’s a gulf in benchmarks that test all cores. In Geekbench, the Geekom A8’s 13,237 return is light years away from the MSI’s 8,651, and the gap grew in Cinebench R23 with 16,615 against 6,342.

The gulf in performance continued into gaming, as illustrated by the Geekom’s return of 3,215 in 3DMark Time Spy, almost twice the MSI’s 1,711, and where the Ryzen’s 780M graphics proved good enough for 35fps in *Shadow of the Tomb Raider* (at 1080p High settings) the MSI could only rustle up 22fps.

So, if all-out speed is your priority, the Cubi NUC is not your best choice. However, few people need such power, especially in businesses where MSI is certainly targeting this mini PC. For instance, it includes two 2.5GbE ports, one of which can be used for out-of-band management, while those IT directors who need to show they’re making environmental strides will appreciate that 43% of the plastics are PCR. MSI takes renewables seriously, too, with 92% of its factory’s power coming from renewable sources.

I also asked MSI about its customer support. You’ll be buying from resellers rather than direct from MSI, but for businesses its approach is to have a ready supply of buffer stock



**ABOVE** The Cubi NUC 1M is a great mini PC provided that all-out power isn't a priority



**“As ever with NUC designs, the big advantage of the Cubi comes via its ability to squeeze into any situation”**

**BELOW** The Cubi’s impressive range of connectivity includes two 2.5GbE ports



so that faulty units can be swapped out and then fixed at MSI’s recently established UK service centre. It’s hardly Dell next-business-day on-site support, but there is a plan.

The Cubi should be of particular appeal to businesses wanting to mount mini PCs on a monitor. If you buy a compatible MSI display then its power switch can also switch on the PC, but otherwise MSI supplies an external power switch that sits at the end of a cable and means users don’t need to reach round the back. You can even power the Cubi via USB-C, with up to 100W of power, massively simplifying cable management. There are two USB-C ports here, both supporting Thunderbolt 4, and when you add Wi-Fi 7, Bluetooth 5.3, four

USB-A ports, a microSD card reader and two HDMI 2.1 ports it’s hard to think of something that isn’t included.

Those looking for a home entertainment system will be pleased to discover those HDMI ports support CEC (so universal remotes will work), and there are plenty of ways to extend storage. A second M.2 socket sits empty, albeit M.2 2242 rather than 2280, and you can mount a 2.5in SSD externally via four screw slots on its bottom. Or plug fast external storage into the USB-C ports.

As ever with NUC designs, the big advantage of the Cubi is its ability to squeeze into any situation. Here, you could use the Cubi for digital signage (the Core 3 version will be fine for such tasks), in schools, in businesses and in homes. It isn’t the fastest mini PC around, nor the smallest, but for versatility it’s an absolute winner.

**TIM DANTON**

### SPECIFICATIONS

10-core (2 P-cores, 8 E-cores) Intel Core 7 150U processor • 16GB DDR5-5200 RAM • Intel Graphics • 1TB M.2 NVMe Gen 4 SSD • microSD card reader • Wi-Fi 7 • Bluetooth 5.4 • 2 x 2.5GbE ports • 2 x HDMI 2.1 • 2 x Thunderbolt 4/USB-C 4 • 4 x USB-A 2 • 3.5mm combo jack • 50 x 136 x 133mm (WDH) • 630g • Windows 11 Pro • 3yr warranty • part code, 1M-016UK





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## TCL RayNeo Air 2s

Matches the best for visual hardware and audio quality, but TCL needs to work on its software

SCORE ★★★★★

PRICE \$400 from rayneo.com

Smart glasses are an idea that keeps coming around: recently we've seen the Lenovo Legion Glass (see issue 352, p70), the Ray-Ban Meta Smart Glasses (see issue 352, p71) and the Carrera Smart Glasses with Alexa (see issue 353, p70). However, no-one's yet managed to drag the idea into the mainstream. Could TCL RayNeo's new Air 2s AR glasses be the ones that hit the big time?

They certainly make a style statement. The shape resembles a pair of classic Ray-Ban Wayfarers, but RayNeo's design eschews the Wayfarers' thick rims in favour of a futuristic full-front visor. The silver temples offer three-point tilt adjustment and ultra-flexible hinges, and at only 79g they're comfortable to wear, even for prolonged periods. The frame does, however, suffer from the same design challenge as most other AR glasses we've tested: the front sits about half an inch out from your face, which looks unnatural from certain angles.

Another potential issue is the heavy dark tint of the visor. If you're outdoors on a sunny day this won't be a problem, but when you try to use these glasses indoors, the experience is rather gloomy. The RayNeo Air 2s glasses also don't offer dioptre adjustments, so if you need prescription lenses you'll have to either invest in custom inserts or wedge the Air 2s frames over your regular specs – which is not a great experience, as the virtual display is liable to get blurred or cut off.

Getting started with the Air 2s is easy. Plug them into any laptop, smartphone, gaming handheld or tablet and – as long as your device can output DisplayPort over USB-C – they'll immediately start mirroring the display. The twin Full HD microOLED displays project a virtual impression of a 20.1in screen in front

of your eyes at a perceived distance of six metres, and in practice this looks gigantic.

Beyond display mirroring, these glasses don't offer a huge amount in terms of AR tricks. The RayNeo XR app for Android lets you explore a selection of visual demos, small games and a web browser, but it's of little practical use. The Mirror Studio app for Windows is more ambitious, allowing you to project selected desktop windows into 3D space, but I found it confusing, and even once I had my windows successfully floating, interacting with them felt fiddly and unnatural.

Thankfully, when it comes to entertainment, the Air 2s glasses do a stunning job. The virtual display is beautifully crisp and ultra-smooth (with a refresh rate up to 120Hz); colours are vivid, highlights are bright and blacks are rock solid,

thanks to a 100,000:1 contrast ratio. In fact, the heavy tint helps here, as it provides a dark backboard against which your content can really shine out.

Games and movies on the Air 2s glasses look simply jaw-dropping. Watching *Blade Runner 2049* I was practically

awestruck by the neon hues and irradiated oranges that dress Los Angeles and Las Vegas. If you want a less eye-socking experience, the right-hand temple rocker switch lets you easily adjust the brightness of the display, or you can tap the action button to bring up an onscreen menu and switch between standard, vibrant and soft colour profiles.

**ABOVE** Films and games look amazing on the twin Full HD microOLED displays

**"When it comes to entertainment, the Air 2s glasses do a stunning job. The virtual display is beautifully crisp and ultra-smooth"**

**LEFT** The tiny speakers built into the frame produce quite stunning audio

**BELOW** The design is similar to a pair of classic Ray-Bans

Perhaps even more impressive is the audio experience. The little speakers you typically find built into AR glasses often lack power and low-end warmth, but the TCL RayNeo Air 2s' quad-driver audio system sounds fantastically rich and solid, while spatial audio support adds an extra level of immersion to compatible movies and media.

That means these glasses aren't just good for films and games. I fired up the video to Audioslave's early-2000s riff-ripper "Cochise" and was blown away by the overall audiovisual experience. It may have been the best three minutes and 56 seconds of my life, or at least that portion of it I've spent wearing AR glasses: it sounded so good I afterwards found myself instinctively reaching up to remove

earbuds that weren't there. As is inevitable with open-ear speakers, there is audio bleed, but if you get complaints then you can activate whisper mode. This applies a specific EQ profile designed to minimise bleed, and although it isn't perfect it should appease your audio neighbours.

In all, the RayNeo Air 2s AR glasses are a terrific entertainment accessory. The only disappointment is that the bundled apps are so limited. The Air 2s could also be a powerful tool for productivity or a handy AR companion for when you're out and about, but the software just isn't mature or versatile enough.

Still, if you like the idea of immersive media experiences on an enormous virtual screen, the RayNeo Air 2s AR glasses are a brilliant piece of hardware. At the time of writing, they're not available on Amazon UK, but they can be ordered directly from [rayneo.com](http://rayneo.com) – and because they're so new, I'm hopeful that TCL and RayNeo will keep developing the software, and realise more of these glasses' potential in the future. **RAEL HORNBY**

### SPECIFICATIONS

2 x 0.55in 120Hz microOLED displays • 1,920 x 1,080 resolution per eye • 600cd/m<sup>2</sup> peak brightness • 4 x microspeakers • beamforming mic array • 175 x 154 x 47mm (WDH) • 79g • 1yr warranty



# Your bonus software

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**£145**

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

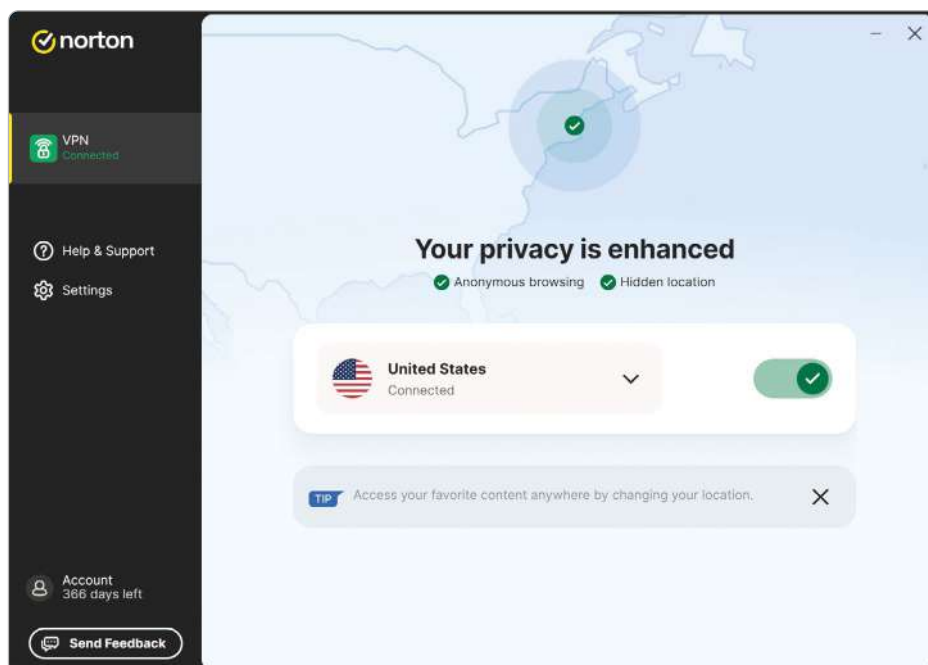
## Norton Secure VPN 2024

You need to keep your wits about you when using a PC: viruses, scams and worse can put your valuable personal data at risk. However, one of the most common threats – and one that's easy to overlook – is the danger of insecure wireless networks.

■ **Single-device, one-year licence worth £40**  
■ **uk.norton.com REQUIRES Windows 7 or later; 200MB hard drive space; online registration**

Sit down to work in a café, or connect to public Wi-Fi at an airport or library, and you're putting your personal data in the hands of an unknown network administrator. Worse, on fully open Wi-Fi networks, your communications can be spied on by anyone else using the same hotspot. Come to that, do you know for sure that the network you're connected to really is the official one, and not a malicious imitator?

The best way to protect your privacy and security on untrusted networks is by using a virtual private network (VPN) to encrypt and shield your activity. One excellent option is Norton Secure VPN – and this month we're offering PC Pro readers a one-year, one-device subscription as part of our downloads bundle.

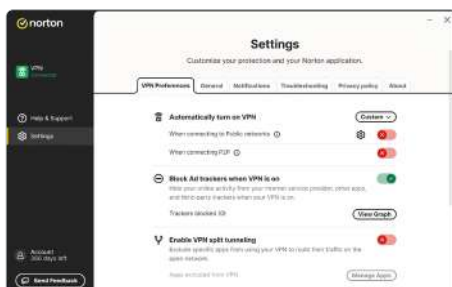


A VPN creates a secure tunnel between your computer and a trusted third-party server, which then forwards the connection to your desired destination. Data passing through the tunnel is encrypted using military-grade algorithms, so that no-one can intercept it in transit. That includes the operators of public Wi-Fi networks, which makes working from unfamiliar locations far less risky.

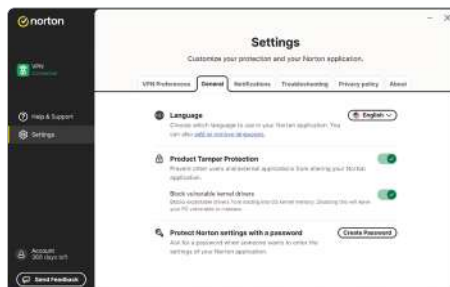
As well as securing your data, a VPN lets you browse the internet anonymously, so your activities

can't be traced back to your computer. You can also make it look like you're browsing from a different country – so when holidaying abroad, for example, you could use a VPN to change your virtual location and catch up on UK-only streaming services that would otherwise be blocked.

Norton Secure VPN works on Windows, macOS, iOS and Android, and your licence includes unlimited data transfer – so you can leave it running continually, or use it only when needed.



**ABOVE** Norton VPN can also block advertising trackers, and it activates automatically when you connect to public networks



**ABOVE** Tamper protection settings prevent other applications running on your computer from interfering with the VPN connection

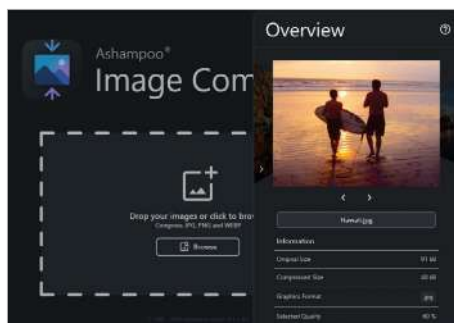


**ABOVE** Let the VPN automatically connect to the fastest available server, or choose for yourself from 29 virtual locations worldwide



## Image Compressor 1.0

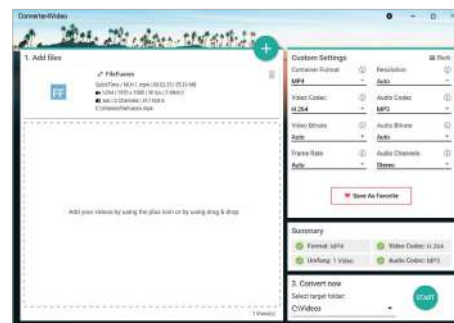
- Save hard drive space by resizing and efficiently compressing JPEG, PNG and WebP images
- Get started quickly by dragging and dropping images onto the application window
- Set your desired image quality, pick an output location and start compressing – it's that easy!



■ Full product worth £20 ■ [ashampoo.com](https://ashampoo.com)  
**REQUIRES** Windows 10 or later; 100MB hard drive space; online registration

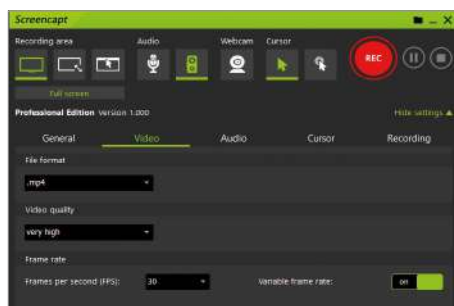
## Converter4Video 2024

- Batch-convert your videos to modern formats for easy playback on smartphones and tablets
- Import videos from multiple sources, choose your output format, and leave it to process them
- Target specific devices or use custom formats to pick the container, resolution, codec and more



■ Full product worth £30 ■ [abelsoft.net](https://abelsoft.net)  
**REQUIRES** Windows 7 or later; 200MB hard drive space; online registration

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**REQUIRES** Windows 7 or later; 50MB hard drive space; online registration

- Create webinars and tutorials, or capture live gaming sessions at up to 120fps
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- Include a webcam window in your recording to make your screen recordings more personal

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- Find your favourite tracks online and stream or download them to your computer
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**2** Once you're in the download area, you can access this month's bonus software by navigating to the relevant product page and clicking the red Install button. For trial software, freeware and other downloads, click the Install button below the product description, or follow the onscreen instructions (please make sure to read these carefully).

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## Samsung Smart Monitor M8

A great choice if you're after a work monitor during the day and for watching TV and films after hours

**SCORE** ★★★★★

**PRICE** £441 (£529 inc VAT)  
from [samsung.com](https://www.samsung.com)



**R**emember those innocent days before AI when “smart” was the hottest buzzword in tech?

Samsung was one of its keenest advocates, applying it to the Smart Monitor M7 (see issue 326, p93) back in 2021, and for good reason. That was a 31.5in 4K monitor with Wi-Fi 5 that included Tizen OS, so you could use it for streaming TV or smart home duties without the need for a PC.

Now we have the M8, which is a 31.5in 4K monitor with Wi-Fi 5 that includes Tizen OS. But even though the M8 costs £140 more than the M7, this is a far better offering.

The main reason: improved image quality. The M8's VA panel shares the same technology as its predecessor, but peak brightness has almost doubled to 461cd/m<sup>2</sup> and it now has a much wider and more vibrant gamut: 84% of the DCI-P3 space is enough to make films and TV shows look great, and a huge jump up from the 69% I saw previously.

Another major positive is that the new panel's whites are far better suited to working, and with so much desktop area to use the M8 is a capable work monitor. Gamers should steer clear, however, as the 60Hz refresh rate is an immediate handbrake. That's a shame, as the hefty pair of 5W speakers add atmosphere to games.

You have a choice of inputs, with one HDMI and one USB-C. The latter charges at up to 65W, which is fine for

regular laptops but won't be enough to feed high-performance models. It can't go higher because Samsung's external power brick is rated at 140W and the M8's power demands peaked at 61W when I pushed it to full brightness; that leaves little wiggle room. At 200cd/m<sup>2</sup> its power draw settled at 37W.

That's a high figure even for a 4K panel, but bear in mind that Tizen OS is always running in the background. Click the Home button on the remote control and you'll drop into an interface that will be

familiar to Samsung TV owners, giving you access to its TV Plus platform for viewing live channels. Or hit the Netflix, Disney+ or Prime Video buttons to jump straight to those apps.

There are extra services, too. For example, thanks to the supplied 1440p webcam – which attaches magnetically via Pogo-style buttons at the top rear – you can fire up the free fitness programs and the M8 will track your movement as you go through the exercises. Or you may prefer to use the M8 as a SmartThings hub.

Connect a mouse and keyboard – the M8 supports Bluetooth 5.2 but there are also two USB-A ports – and this can even turn into a remote monitor. You can use Easy Connection, which requires you to install Samsung's software on your target PC, screen mirroring, Samsung's DeX desktop environment (if you own a recent Samsung phone or tablet), plus Office 365. But only if you're a masochist who likes eternal delays before docs load.



**ABOVE** The M8's 5W speakers and wide colour gamut make it a great choice for films

**“Even though the M8 costs £140 more than the M7, this is a far better offering. The main reason: improved image quality”**

**LEFT** The supplied 1440p webcam can track your workouts

**BELOW** The stand offers 120mm of height adjustment, but no swivel option

This variety of tasks can make the M8 confusing to use. Tap the remote control by mistake and you're dropped into Tyzen OS, and you must then fight through the menu system to find your PC. It's harder to control settings on the M8 than normal monitors, too. Although Samsung provides an OSD, which you control via the mini joystick on the rear, you have to wade through submenus simply to adjust

brightness. Nor do you have the same level of control over gamuts or settings as you would find on a similarly priced non-smart 4K monitor.

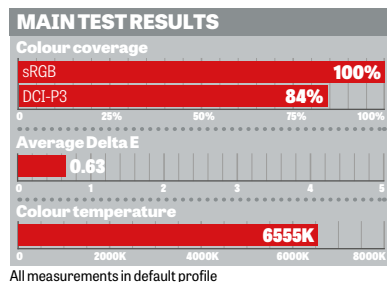
Although it can pivot into portrait mode, this isn't the most flexible of stands. It tilts 2° forward and 15° backwards, with no swivel option. At least this time – unlike the M7 – you get 120mm of height adjustment.

Whether the Smart Monitor M8 is right for you boils down to your intended usage. If it's a roughly even split between streaming TV services and working, then it's a strong choice at a competitive price. But if you'll be spending any more than 80% of your time working, then I'd stick to a regular monitor and bolt a TV stick into its HDMI port instead.

**TIM DANTON**

### SPECIFICATIONS

31.5in 3,840 x 2,160 VA panel • up to 60Hz refresh rate • 8-bit + FRC panel (1.07 billion colours) • 4ms response time • 2,560 x 1,440 webcam • Wi-Fi 5 • Bluetooth 5.2 • HDMI 2 • USB-C (65W power delivery) • 2x USB-A 2 • 2x 5W speakers • Tizen 8 OS • remote control • pivot • 120mm height adjustment • -2° to 15° tilt • 713 x 200 x 496-616mm (WDH) • 7.2kg • 1yr RTB warranty • part code, LS32DM801UXXU





## pro-series

### mid (PRO1)



£449.99

**CPU** AMD RYZEN 5 8500G  
**Core** 6 Cores - 12 Threads  
**Clock** (3.5/5Ghz Turbo)  
**Mob** ASUS TUF A620M-PLUS WIFI  
**RAM** ADATA 16GB DDR5 5600Mhz  
**M.2** TRANSCEND 1TB M.2 nVME  
**GPU** AMD RADEON Graphics  
**Case** KOLINK Observatory HF MESH  
**O/S** \*NO OPERATING SYSTEM\*  
**PSU** BUILDER 500W PSU

### Max (PRO2)



£979.99

**CPU** AMD RYZEN 5 7600X  
**Core** 6 Cores - 12 Threads  
**Clock** (4.7/5.3Ghz Turbo)  
**Mob** ASUS PRIME B650M-A WIFI II  
**RAM** ADATA 32GB DDR5 5600Mhz  
**M.2** TRANSCEND 1TB M.2 nVME  
**GPU** NVIDIA RTX4060 TI 16GB  
**Case** 1stPlayer D3-A aRGB - Black  
**O/S** \*NO OPERATING SYSTEM\*  
**PSU** CIT 700W PSU

### UBER (PRO3)



£1159.99

**CPU** INTEL Core i5 14600K  
**Core** 14 Cores - 20 Threads  
**Clock** (2.6/5.3Ghz Turbo)  
**Mob** ASROCK B760M-H/M.2  
**RAM** ADATA 32GB DDR5 5600Mhz  
**M.2** ADATA 2TB S70 Blade M.2 nVME  
**GPU** NVIDIA RTX4060 TI 16GB  
**Case** GAMEMAX F15M MESH  
**O/S** \*NO OPERATING SYSTEM\*  
**PSU** BEQUIET 850W Gold PSU

## Aurora RANGE

i3



[AUR1]

£629.99

**CPU** INTEL Core i3 14100F  
**Core** 4 Cores - 8 Threads  
**Clock** (3.5/4.7GHz)  
**Mob** ASROCK B760M-H/M.2 DDR5  
**RAM** ADATA 16GB DDR5 5600Mhz  
**M.2** TRANSCEND 1TB M.2 nVME  
**GPU** NVIDIA RTX3050 8GB  
**Case** GAMEMAX Abyss Mini RGB  
**O/S** MICROSOFT Windows 10/11  
**PSU** CIT 600W Bronze PSU

i5



[AUR2]

£999.99

**CPU** INTEL i5 14400F  
**Core** 10 Cores - 16 Threads  
**Clock** (Turbo 4.7Ghz)  
**Mob** ASROCK B760M-H/M.2 DDR5  
**RAM** CORSAIR 32GB DDR5 6000Mhz  
**M.2** ADATA 2TB M.2 NVMe  
**GPU** NVIDIA RTX4060 8GB  
**Case** CORSAIR iCUE 4000X  
**O/S** MICROSOFT Windows 10/11  
**PSU** CORSAIR 650W PSU

i7



[AUR3]

£1599.99

**CPU** INTEL Core i7 14700KF  
**Core** 20 Cores - 28 Threads  
**Clock** (3.4/5.6Ghz Turbo)  
**Mob** ASUS PRIME Z790-P WIFI - DDR5  
**RAM** CORSAIR 32GB DDR5 6000Mhz  
**M.2** ADATA 1TB S70 Blade M.2 nVME  
**GPU** NVIDIA RTX4070 12GB  
**Case** CORSAIR iCUE 4000X RGB  
**O/S** MICROSOFT Windows 10/11  
**PSU** CORSAIR 650W Gold PSU

www.palicomp.co.uk





## Netgear Nighthawk RS300

The first affordable Wi-Fi 7 router is fast today, with promise for more in the future, but don't rush to buy

SCORE ★★★★★

PRICE £250 (£300 inc VAT)  
from amazon.co.uk

**W**i-Fi 7 has been slow to catch on, but now that new laptops are regularly arriving with built-in support for the new wireless standard (officially dubbed 802.11be), it might finally be ready to hit the mainstream.

If that's so then the Nighthawk RS300 has arrived at the ideal time. It's the first Wi-Fi 7 router we've seen with a remotely sensible price tag, undercutting Amazon's Eero Max 7 (see issue 352, p68) by a cool £300 and slashing more than 60% off the cost of Netgear's own Nighthawk RS700S (see issue 353, p76).

Despite the relatively low price, the RS300 offers a decent specification. The legacy 2.4GHz network runs at 700Mbps/sec, while the 5GHz radio is rated at 2.9Gbps/sec and the 6GHz band claims a nippy maximum connection rate of 5.9Gbps/sec. Although these aren't best-in-class speeds, there's more than enough bandwidth here for most households and home offices. The router promises a reasonable range, too: Netgear claims the RS300 is suitable for floorspaces of up to 185m<sup>2</sup> (the average UK home is closer to 100m<sup>2</sup>) and up to 100 devices.

As well as having decent wireless capabilities, the RS300 is great for wired connectivity, offering a 2.5GbE WAN port and twin 2.5GbE LAN connectors. Two standard gigabit sockets can also be aggregated together to provide additional bandwidth for a compatible NAS device. It's a strong specification for the price, and I was pleased to see a USB connector as well for easy file sharing, either locally or over the internet. It's just a shame that this is limited to 5Gbps/sec, as this won't



allow you to enjoy the full performance of a fast USB SSD over your home network.

### ■ Soft touch

The system software holds no surprises: the RS300 uses the exact same firmware platform as every other Nighthawk router I've seen in the past eight years, with no new features for the Wi-Fi 7 age. Still, this makes initial setup very quick and easy. Once you've installed the Nighthawk mobile app you can simply use your phone's camera to scan a QR code to identify and connect to the router, after which the rest of the process is largely automatic.

More advanced management features such as port forwarding and QoS can be configured in the familiar web interface. There's also an inbound VPN server, which provides an easy way to access your home network over the internet, although the RS300 doesn't support outbound VPNs as found on Asus routers. The other notable limitation is that

**LEFT** The RS300 offers a decent specification for a relatively low price

Netgear's network security and parental controls modules are supplied only as 30-day free trials, so if you want to keep them going you'll have to pay an extra £85 and £50 a year each. That's a disappointment when, again, Asus includes both capabilities for free.

### ■ Mixed speeds

The big question, of course, is how it performs. To find out, I plugged the RS300 into an Asustor Drivestor Pro AS3304T NAS appliance via 2.5Gbps/sec Ethernet, then carried my test laptop (equipped with an Intel BE200 2x2 Wi-Fi 7 card) to various rooms of my home and measured average download speeds for a series of 100MB data files. You

**"Netgear claims the RS300 is suitable for floorspaces of up to 185m<sup>2</sup> (the average UK home is closer to 100m<sup>2</sup>) and up to 100 devices"**

can see my results in the graphs opposite, along with figures from the other Wi-Fi 7 routers we've tested.

Clearly, the Nighthawk RS300 can hit very decent speeds, with close-range

downloads in the study racing over the airwaves at up to 140MB/sec – fast enough to fully saturate a gigabit internet connection. We haven't seen any router, at any price, go much faster than this.



**LEFT** Status lights show you clearly what's happening on your network



**RIGHT** The router offers decent wired capabilities as well as speedy Wi-Fi

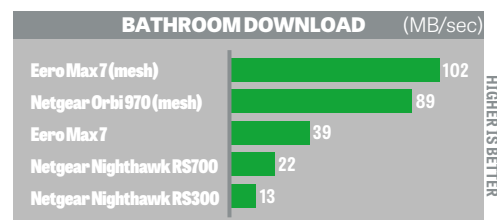
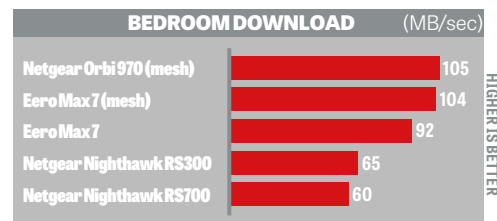
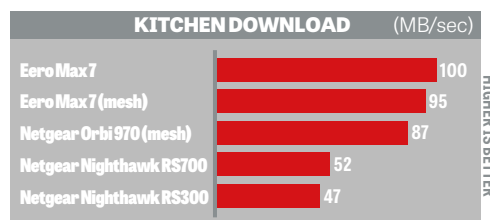
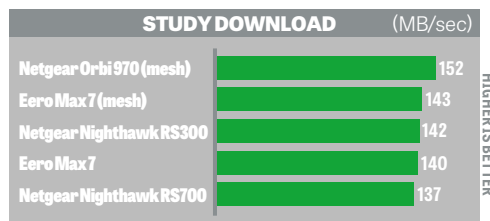


As is inevitable with a standalone router, performance drops off as you move further away, but the RS300 still holds up well. Even when I tried connecting from the bathroom at the far end of my home I got an average download rate of 13MB/sec – more than four times the recommended minimum for streaming 4K HDR video. Unless you live in a stately home, this router's reach and performance should be ample for your needs, whether those involve home entertainment, working from home or moving weighty VMs and video files around a home office network.

## Time for Wi-Fi 7?

We must, however, sound two notes of caution. First, it's worth noting that this router's three radios each only support 2x2 MIMO. Since most client devices use 2x2 receivers, that won't hold back performance for individual connections – but it means there's no bandwidth to spare for when multiple devices want to download at once.

More generally, although the Wi-Fi 7 routers we've tested have all been fast, none has yet been significantly quicker than the best Wi-Fi 6 or 6E models. That's disappointing, in light



of the impressive claims that were made for Wi-Fi 7 when the standard was initially published back in 2021.

The explanation is simple: the big new feature in Wi-Fi 7 is multi-link operation, or MLO. This allows individual devices to combine the 2.4GHz, 5GHz and 6GHz bands together into one ultra-fat data channel, and communicate with the router across all three frequency bands at once, multiplying the available bandwidth whilst

**"Although the Wi-Fi 7 routers we've tested have all been fast, none has yet been significantly quicker than the best Wi-Fi 6 or 6E models"**

improving connection stability. Unfortunately, none of today's Wi-Fi 7 systems uses MLO: all the figures you see in the graphs above represent a single-band connection, as you

would get with Wi-Fi 6.

Hopefully this should be a temporary situation. Netgear has confirmed that it's working on a firmware update to bring MLO to its routers and meshes. However,

until I can install and test it for myself, I can only speculate as to what the real-world benefits of MLO might be – and Netgear hasn't given any hint as to when this update might be available.

As it stands, the RS300 is still a decent router. Its wireless capabilities already go well beyond most people's needs, and multi-gigabit Ethernet support is excellent, too. By Wi-Fi 7 standards it's a veritable bargain, so if you're eager to upgrade your network, perhaps to go with a new Wi-Fi 7-capable laptop, this is probably the smartest way to do it.

Even so, it's not a wholly compelling proposition. Out of the box, the Nighthawk RS300's Wi-Fi performance isn't much different to what you could get from a regular Wi-Fi 6 router, and it remains to be seen what benefit MLO will bring – whenever it finally appears. There's no doubt that Wi-Fi 7 in general is the future, but at this point I couldn't blame you for saving your money and sticking with what you've got until the new technology is really ready to shine. **DARIEN GRAHAM-SMITH**

## SPECIFICATIONS

Tri-band 2.4GHz/5GHz/6GHz router • 6 streams • 2.5GbE WAN, 2 x 2.5GbE LAN, 2 x GbE LAN • 2GHz quad-core processor • 150 x 102 x 249mm (WDH) • 2yr limited warranty



**RIGHT** Netgear's Nighthawk RS700S costs more than twice as much as the RS300

Nighthawk RS700S, and adds a dedicated backhaul network rated at 8.6Gbps/sec to ensure data zips smoothly from station to station. As you can see from our graphs, this allows the Orbi system to deliver excellent speeds even at long range. The Orbi also beats the RS700S for wired connectivity, with both 10GbE and 2.5GbE on every unit.

For a more modular solution, look to Amazon's Eero Max 7 system. You can buy a single Eero station for £600 and use it as a conventional router, or pair multiple units together to form a mesh. While the Eero's performance stumbled in our initial review, we've since retested it with newer firmware and an upgraded Wi-Fi 7 card, and download speeds are now respectable – indeed, a single Eero decisively outpaced Netgear's standalone routers at medium range.

Our only concern is that the Eero may have less headroom for future performance gains: Amazon hasn't committed to adding MLO to the system, and

only claims a top connection rate of 4.3Gbps/sec. The bundled software is basic, too: to unlock the full feature set you have to pay an extra £100 a year for an "Eero Plus" subscription, which includes security, parental controls, Wi-Fi analytics, dynamic DNS and internet failover.

## What else is out there?

Wi-Fi 7 is reaching a tipping point. In the next few months we expect to see several next-generation routers go on sale, including multiple models from companies such as Asus and TP-Link, so if you're patient you'll have plenty of options.

If you want to get ahead of the curve, though, we have previously tested three alternatives to the Nighthawk RS300 that could suit your needs. The first is Netgear's upmarket Nighthawk RS700S: this promises twice the speed of the RS300 on all three radio bands, with the 6GHz network claiming an ultra-fast peak of 11.5Gbps/sec. That's accomplished with 4x4 MIMO, so (as our graphs indicate) an individual laptop or tablet with a 2x2 network card won't see much advantage over the RS300, but it will make a difference when two devices are connected at once.

The RS700S also offers 10Gbps/sec Ethernet for both WAN and LAN connections – and it comes with a year of Netgear Armor coverage included in the price (the "S" at the end stands for Security). At £799 inc VAT, though, it's considerably more expensive than the RS300.

If you need wide-area coverage, Netgear also offers a Wi-Fi 7 mesh in the form of the Orbi 970 (see issue 357, p62). This costs a huge £1,500 for two mesh units or £2,200 for three, but you get an uncompromising system: each Orbi node matches the Wi-Fi capabilities of the

**RIGHT** Amazon's Eero Max 7 can be used as a regular router or paired together as a mesh



## Xiaomi 14 Ultra

The best camera phone you can buy, and now with a price that brings it into the reach of mortals

SCORE ★★★★★

PRICE £832 (£999 inc VAT)  
from [xiaomi.com](https://www.xiaomi.com)

**T**he Xiaomi 14 Ultra isn't exactly new – it first appeared in the UK back in February. However, the steep £1,299 launch price put it in an exclusive price bracket. Now it's had a significant drop to £999, making it a rival to the latest iPhone Pro and Pixel Pro handsets, or a cheaper alternative to Samsung's top-tier Galaxy S24 Ultra (see issue 354, p58).

At the new price, it's a good deal. The phone comes with 16GB of RAM and 512GB of storage, and the camera provision is unrivalled: the rear of the case is dominated by a sizeable circular protrusion that houses four 50MP Leica cameras.

The design isn't wholly ergonomic. The large camera assembly makes it top-heavy, and when I tried to use the phone one-handed I found it tended to flop out of the top of my hand. I also worried about scratching the large glass covering that sits over the lenses; in the event, the strengthened Xiaomi Shield glass survived my month of testing without a blemish, but I still feel uneasy about what could happen over a year or two of use.

Overall, though, it's a good-looking design. Its aluminium frame is solid in the hand, and the back is covered in hard-wearing "nano-tech vegan leather", which didn't pick up any marks during my testing. The only real compromise is a lack of colour options: the phone only comes in black or white.

The front of the phone is almost entirely covered by a 6.7in AMOLED display. Its 3,200 x 1,440 resolution translates into an impeccably sharp 522ppi, and with a peak brightness of 3,000cd/m<sup>2</sup> it literally outshines almost every other phone, including the iPhone 15. The variable refresh rate automatically scales between 1 and 120Hz, providing the best possible balance of efficiency and smoothness.



you manually set the aperture, ISO, shutter speed and white balance.

The CPU in the Xiaomi 14 Ultra is the same one found in almost every current high-end phone, namely Qualcomm's Snapdragon 8 Gen 3. This ensures everything feels quick, from the fingerprint scanner to loading and switching apps. Even in demanding games I didn't experience any performance

On the software front, Xiaomi's new HyperOS platform looks like the old MIUI OS, but feels more fluid and responsive. The layout differs from other Android-based phones – notably, Xiaomi doesn't use an app drawer – but it's clean and easy to navigate. It also includes a set of bundled Xiaomi apps, which are of mixed quality. The gallery app integrates neatly with Google Photos, and helps keep your photos backed up with minimal human intervention, but others are redundant. Annoyingly, not all of them can be uninstalled.

But the primary attraction of this phone is its extraordinary camera setup. The main camera puts an all-new 23mm Leica lens in front of a one-inch, 50-megapixel sensor, and the results are stunning. My test shots displayed terrific tonal detail, probably helped by the camera's

variable f/1.63 to f/4.0 aperture; bright areas were never blown out, while darker areas were clean and well defined. I'd say the Xiaomi's main camera even beats the Samsung Galaxy S24 Ultra's, producing images full of vibrancy.

For closer framing, you can switch to the fixed 75mm telephoto lens, or the periscope zoom that goes up to 120mm. Having grown accustomed to digital zooms on smartphones, I loved the long optical zoom range, and image quality was again excellent. An ultrawide camera rounds out the roster with a 122-degree field of vision and a minimum focus distance of 5cm for macro photography. While all cameras work well in point-and-shoot mode, optional pro controls let

**ABOVE** The four 50MP cameras dominate the rear of this phone



**"The main camera puts an all-new 23mm Leica lens in front of a one-inch, 50-megapixel sensor, and the results are stunning"**

**LEFT** The cameras make the phone top-heavy, but they're well worth it

drops, and loading bars were few and far between. The Game Turbo app adds options to boost performance further, at the expense of battery life.

If you'd rather save energy, you can stick to the balanced, battery saver or ultra battery saver power modes. In balanced mode I got two full days of average use from a single charge, and recharging is a breeze: an empty battery can be refilled in only 33 minutes using the supplied 90W wired charger, and there's also support for 80W wireless charging. A handy battery check-up feature not only helps you preserve long-term battery health but gives tips on making

your remaining charge last as long as possible.

The Xiaomi 14 Ultra is hard to fault, and the new lower price only sweetens the deal. Performance and specifications are up there with the best, the screen is fantastic, and the premium design and build quality are only slightly marred by the unbalanced weighting.

More to the point, this is arguably the best camera phone ever made, at any price. It takes high-resolution photos that are crisp, detailed, vibrant and beautifully free from noise; if you're a photography enthusiast looking for a high-quality camera that's conveniently built into a smartphone, the Xiaomi 14 Ultra is hard to beat. **PAUL HUTTON**

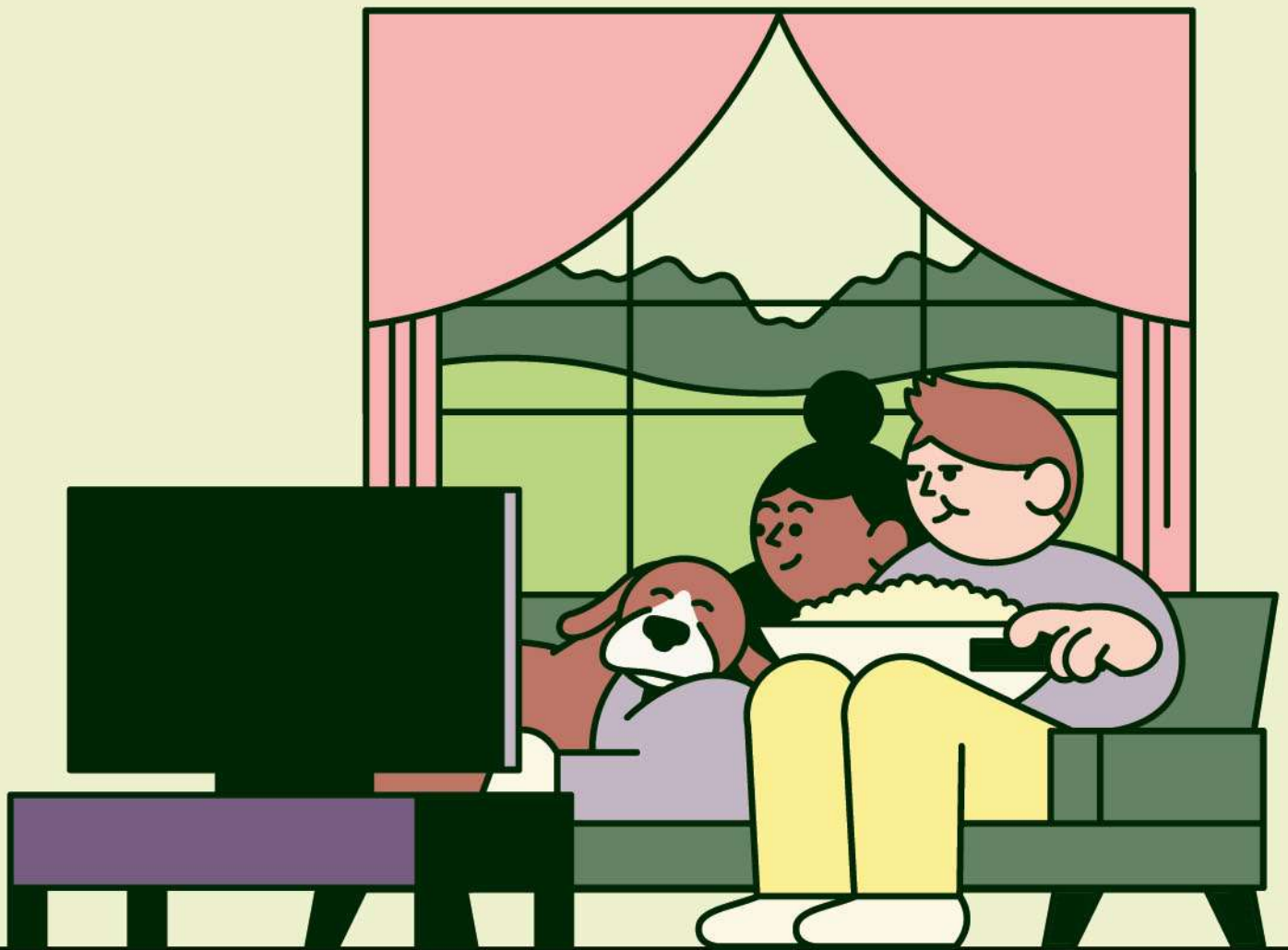
### SPECIFICATIONS

8-core Qualcomm Snapdragon 8 Gen 3 SoC • 16GB RAM • Adreno 750 graphics • 6.7in 120Hz AMOLED screen, 1,440 x 3,200 resolution • 5G • 512GB storage • IP68 • quad 50MP/50MP/50MP/50MP rear cameras • 32MP front camera • Wi-Fi 7 • Bluetooth 5.4 • NFC • 5,000mAh battery • USB-C 3.2 Gen 2 • Android 14 with Xiaomi HyperOS • 75 x 9.2 x 161mm (WDH) • 220g • 2yr warranty



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## OnePlus Nord CE 4 Lite

A big battery and 6.7in OLED screen give this budget phone appeal, but better low-cost options are available

**SCORE** ★★☆☆

**PRICE** £208 (£249 inc VAT)  
from [oneplus.com](https://www.oneplus.com)

**T**he OnePlus Nord CE 4 Lite grabs attention with an arrestingly low price. At £249 inc VAT it's hugely affordable, yet it still offers decent performance and battery life, plus bang-up-to-date system software and a generous 256GB of storage.

It's not a phone that's likely to win any design awards. The casing (in your choice of "Mega Blue" or "Super Silver") is chunky but clean, with no extraneous buttons or switches – not even the handy alert slider found on some other OnePlus mobiles. The only real design feature to speak of is the camera panel on the rear; a reflective panel around the lenses makes them look bigger than they actually are, but they don't stick out far and the phone only wobbles slightly when placed flat on a surface.

The plastic construction means the phone is fairly light at 191g, while an IP54 rating means it's well protected against dust, but in terms of waterproofing it isn't designed to survive anything more than splashes. Don't drop the Nord CE 4 Lite in the bath. On the plus side, this is one of the few phones on the market still to offer a 3.5mm headphone jack.

The big case of the Nord CE 4 Lite also allows for a large 6.7in AMOLED display. It's sharp and smooth, with a 1,080 x 2,400 resolution and a 120Hz refresh rate. An under-display fingerprint scanner is built in too, along with OnePlus' Aqua Touch technology, which helps the phone accurately register touch even when you have wet hands. However, colour performance and brightness are fine rather than exceptional: put the Nord CE 4 Lite next to an iPhone or Google Pixel and it will look subdued by comparison.

The phone comes preloaded with OnePlus' OxygenOS 14.1 system software, which is based on the latest Android 14 release. Custom features include Zen Space, which lets you lock



your phone to avoid distractions, and a good range of personalisation options. Less pleasingly, it also comes with a boat-load of pre-installed apps; there's nothing especially

heinous – think LinkedIn, Netflix, Facebook, Amazon Shopping and AliExpress – but the bloat is still annoying. For the future, OnePlus has promised two years of major OS updates and a further three of security updates.

That's not a huge amount, but this might not be a phone you plan to keep for more than three years anyway.

One way that OnePlus has kept the price of the Nord CE 4 Lite down is by streamlining the camera capabilities. It has the same 50-megapixel, f/1.8 main sensor as many budget phones, plus a lightweight 2MP, f/2.4 companion that frankly seems rather pointless. There's no ultrawide camera, nor a telephoto lens, although the 10x digital zoom worked better than I'd feared. The main camera took decent photos, with acceptable tone and detail, although they're neither bold nor colourful. If there's any AI enhancement going on behind the scenes I didn't detect its effect, but you do get a magic eraser

**ABOVE** The large 6.7in AMOLED panel is sharp and smooth, and battery life is superb

**LEFT** Extraneous buttons and design flourishes are kept to a minimum

**"If there's any AI enhancement going on behind the scenes I didn't detect its effect, but you do get a magic eraser feature"**

**BELOW** There are no ultrawide or telephoto lenses here, while the main camera is basic

feature, which isn't common in phones at this price.

Other than that there's a workable minimum of shooting options. Photographers get portrait, pro, night and panorama presets, while video mode shoots at up to 1080p resolution at 30fps, with dual-view, time-lapse and slow-motion options.

Performance is another area where OnePlus has kept the cost down. The Nord CE 4 Lite uses the Snapdragon 695 chip, which was launched in 2022; while this is fine for everyday use – especially since it's partnered with a decent 8GB of RAM – you can tell it's not a powerhouse. When playing high-end games I occasionally noticed lag or stutter, and during intense action I found that inputs could be a little delayed. The audio from the

little stereo speakers isn't exactly immersive either, although as I've mentioned you can plug in wired headphones, or use wireless ones with Bluetooth 5.1.

If there's one area where the Nord CE 4 Lite stands out, it's battery life. The phone packs a 5,110mAh battery that easily lasts into a second day of use, whether you're just checking the weather or spending the day on the sofa watching YouTube. Equally laudable is its recharging speed: partner this phone with an 80W charger and it will go from empty to full in just over half an hour. You don't

get any sort of charger in the box, only a cable.

Like most low-cost phones, the OnePlus Nord CE 4 Lite has its ups and downs. It's a very usable all-rounder with a big screen, versatile software

and excellent battery life, not to mention twice the storage of many rivals. However, if you're focused on value then the A-Listed Moto G54 5G does a great job at an even lower price (see issue 355, p77), while if you want a better experience in gaming or photography, it's worth paying extra for the Samsung Galaxy A55 (see issue 358, p77). **TOM BEDFORD**

### SPECIFICATIONS

8-core 2.2GHz/1.7GHz Qualcomm Snapdragon 695 5G SoC ● 8GB RAM ● Adreno 619 graphics ● 6.7in 120Hz AMOLED screen, 1,080 x 2,400 resolution ● 5G ● 256GB storage ● IP54 ● dual 50MP/2MP rear cameras ● 16MP front camera ● Wi-Fi 5 ● Bluetooth 5.1 ● NFC ● 5,110mAh battery ● USB-C 2 ● Android 14 with OxygenOS 14.1 ● 76 x 8.1 x 163mm (WDH) ● 191g ● 2yr warranty





# Prize draw

# Win Netgear Orbi 970

# Wi-Fi 7 mesh 3-pack

We've teamed up with Netgear to offer one lucky *PC Pro* reader the chance to win the most powerful Wi-Fi 7 mesh system around

**WORTH  
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**I**f you've been waiting to upgrade to Wi-Fi 7, we have excellent news: one extremely fortunate *PC Pro* reader will soon benefit from the stunning Netgear Orbi 970 (see issue 357, p62). It is quite simply the fastest router we've tested, delivering blistering download and upload speeds across a wide area. And we tested the two-pack version; this is the three-pack edition, extending coverage to an astonishing 8,200 square feet.

You can buy it now at [www.netgear.com/uk/home/wifi/mesh/rbe973s](http://www.netgear.com/uk/home/wifi/mesh/rbe973s) or take your chance in this exclusive prize draw. Here are just some of its highlights:

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From 8K streaming to videoconferencing, from gaming to VR, Orbi ensures your family can accomplish everything at once.

#### ■ Up to 27Gbits/sec speed

Unparalleled performance and coverage for your whole home, from the front door to the back garden and from the basement to the loft.

#### ■ 10GbE port

Whether multi-gig cable or fibre, get the fastest speeds available today and tomorrow with a 10GbE internet port.

#### ■ 360° Wi-Fi coverage

Elegant high-performance antennas provide exceptional 360° Wi-Fi coverage across every corner of your home, no matter the layout.

#### ■ Secure and private

Netgear Armor software provides an automatic shield of security for your Wi-Fi and connected devices for real-time protection (one year included).

#### ■ Reimagined speed & reliability

10GbE and 2.5GbE ports unlock unbeatable speed and reliability for wired connections and 10GbE wired backhaul options.

#### ■ Quad-band technology

Exclusive, patented quad-band technology with Enhanced Dedicated Backhaul ensures Wi-Fi stays fast across all devices simultaneously.

#### ■ Easy setup with any service provider

Simply plug Orbi into your modem and set it up with the Orbi app!



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Full terms and conditions found on the prize draw landing page. Please note that we can only send the router to UK addresses. Prize draw ends 15 October 2025.



# CONTENT CREATION WORKSTATIONS



**Workstation technology keeps moving at pace, so we've brought eight of the best options together to find the ultimate content creation powerhouse**

**T**he PC workstation market never stands still. When your activities need the fastest possible desktop computing you'll always be looking for the latest technologies, and manufacturers are happy to oblige. For this reason, if you want to see the pinnacle of PC power, a fully stocked workstation will be it.

This year, we see new generations of Intel and AMD CPUs compared to last

year, the return of the non-Pro AMD Ryzen Threadripper, and new graphics accelerators. But there's still a huge range of components to choose from, and every single system in this labs test has a different combination.

Some trends remain. There are still more AMD processors than Intel, and more Nvidia graphics cards than AMD, but it's great to see all the main contenders represented





in some form, showing that there's healthy competition in the market.

This year, we stuck with the same price points of £4,500 including VAT for the lower end and £10,000 for the higher end. Although there have been global economic difficulties in the past few years, the price inflation in the computing industry has softened, so these two levels are still solid targets for a mainstream general-purpose workstation (£4,500) or a machine with few holds barred (£10,000).

The result is a great selection of systems for every type of content creation workload, from games design and 3D animation to CAD and engineering.

Each system has been put through our gruelling suite of tests. We've even started to consider AI inference, which is still in the early stages but could be increasingly important for creatives soon. Read on to find your perfect creative PC partner.

**CONTRIBUTOR: James Morris**

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| £4,500 SYSTEMS                                |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
|                                               | Armari Magnetar MM16R9                                                                            | InterPro IPW-RL                                                                                                            | Lenovo ThinkStation P3 Tower*                                                                   | LABS WINNER – £4,500<br>PCSpecialist Quantum Goliath R                                            |
| Overall rating                                | ★★★★☆                                                                                             | ★★★★☆                                                                                                                      | ★★★★☆                                                                                           | ★★★★★                                                                                             |
| Buying information                            |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Price (inc VAT)                               | £3,749 (£4,499 inc VAT)                                                                           | £3,642 (£4,370 inc VAT)                                                                                                    | £2,783 (£3,339 inc VAT)                                                                         | £3,750 (£4,500 inc VAT)                                                                           |
| Price of delivery                             | Free                                                                                              | £25 (£30 inc VAT)                                                                                                          | Free                                                                                            | Free                                                                                              |
| Supplier                                      | armari.com                                                                                        | ipworkstations.com                                                                                                         | lenovo.com                                                                                      | pcspecialist.co.uk/reviews                                                                        |
| Service and support                           |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Manufacturer's reliability/<br>support rating | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | N/A                                                                                               |
| Warranty                                      | 3yr RTB (1 month C&R, 2 years parts and 3yr labour)                                               | 3yr RTB (parts and labour)                                                                                                 | 3yr on-site parts and labour                                                                    | 3yr C&R parts and labour                                                                          |
| Core components                               |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Processor                                     | AMD Ryzen 9 7950X                                                                                 | Intel Core i9-14900K                                                                                                       | Intel Core i9-13900K                                                                            | Intel Core i9-14900KS                                                                             |
| Motherboard (make and model)                  | Asus ROG Strix B650E-I Gaming WiFi                                                                | Asus ROG Maximus Z790 Dark Hero                                                                                            | Lenovo W680                                                                                     | Asus ProArt Z790-Creator WiFi                                                                     |
| Expansion slots free/total                    | 2 x RAM slots (0 free), 1 x PCI-E 5 x16 (0 free), 2 x M.2 sockets (0 free), 2 x SATA 600 (2 free) | 4 x RAM slots (0 free), 2 x PCI-E 5 x16 (1 free), 1 x PCI-E 4 x4 (1 free), 5 x M.2 sockets (3 free), 4 x SATA 600 (4 free) | 4 x RAM slots (2 free), 3 x PCI-E x16 (0 free), 2 x M.2 sockets (0 free), 1 x SATA 600 (1 free) | 4 x RAM slots (0 free), 2 x PCI-E 5 x16 (1 free), 4 x M.2 sockets (3 free), 8 x SATA 600 (7 free) |
| RAM fitted/speed                              | 96GB/DDR5 5,600MHz                                                                                | 192GB/DDR5 5,200MHz                                                                                                        | 64GB/DDR5 4,400MHz                                                                              | 192GB/DDR5 5,200MHz                                                                               |
| Graphics                                      |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Make and model                                | AMD Radeon Pro W7800                                                                              | PNY Nvidia RTX 4000 Ada Generation                                                                                         | Nvidia GeForce RTX 4080                                                                         | Asus TUF GeForce RTX 4090 OC Edition                                                              |
| RAM amount                                    | 32GB ECC GDDR6                                                                                    | 20GB GDDR6                                                                                                                 | 16GB GDDR6X                                                                                     | 24GB GDDR6X                                                                                       |
| Outputs                                       | 3 x DisplayPort 2.1, 1 x Enhanced Mini DisplayPort 2.1                                            | 4 x DisplayPort 1.4a                                                                                                       | 4 x DisplayPort 1.4                                                                             | 4 x DisplayPort 1.4                                                                               |
| Drives                                        |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| SSD make and model                            | Crucial T705                                                                                      | Crucial T705                                                                                                               | SK Hynix HFS001TEJ9X102N                                                                        | Samsung 990 Pro                                                                                   |
| Nominal capacity                              | 2TB                                                                                               | 2TB                                                                                                                        | 1TB                                                                                             | 4TB                                                                                               |
| Interface                                     | NVMe M.2 PCI Express 5                                                                            | NVMe M.2 PCI Express 5                                                                                                     | NVMe M.2 PCI Express 4                                                                          | NVMe M.2 PCI Express 4                                                                            |
| Secondary SSD make and model                  | Kioxia EXCERIA Pro                                                                                | Crucial P3 Plus                                                                                                            | SK Hynix HFS001TEJ9X102N                                                                        | N/A                                                                                               |
| Nominal capacity                              | 2TB                                                                                               | 4TB                                                                                                                        | 1TB                                                                                             | N/A                                                                                               |
| Interface                                     | NVMe M.2 PCI Express 4                                                                            | NVMe M.2 PCI Express 4                                                                                                     | NVMe M.2 PCI Express 4                                                                          | N/A                                                                                               |
| Hard disk make and model                      | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | Seagate IronWolf Pro                                                                              |
| Nominal capacity                              | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | 10TB                                                                                              |
| Spindle speed                                 | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | 7200rpm                                                                                           |
| SSD cache                                     | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | ✗                                                                                                 |
| Memory buffer                                 | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | 256MB                                                                                             |
| Optical drives                                | N/A                                                                                               | N/A                                                                                                                        | N/A                                                                                             | N/A                                                                                               |
| Case                                          |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Model (dimensions WDH)                        | Phanteks Evolv Shift XT (173 x 371 x 272mm)                                                       | Fractal Define 7 Compact Black Solid (310 x 536 x 521mm)                                                                   | Lenovo ThinkStation P3 TWR (180 x 370 x 415mm)                                                  | Corsair 5000D Airflow Tempered Glass (245 x 520 x 520mm)                                          |
| PSU make and model (power output)             | Thermaltake Toughpower SFX (850W)                                                                 | Corsair RM1000e V2 Gold (1,000W)                                                                                           | Lenovo 80 Plus Platinum (1,100W)                                                                | Corsair RMx Series Modular 80 Plus Gold (1,000W)                                                  |
| CPU cooler                                    | NZXT Kraken 240mm AIO liquid cooler                                                               | Corsair iCue H150e RGB Elite 360mm Digital liquid cooler                                                                   | Lenovo 125W air cooler                                                                          | Corsair iCUE Link H150i RGB liquid cooler                                                         |
| Interfaces                                    |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Ethernet (rear)                               | 1 x 2.5GbE                                                                                        | 1 x 2.5GbE                                                                                                                 | 1 x 1GbE                                                                                        | 1 x 10GbE, 1 x 2.5GbE                                                                             |
| Wi-Fi (rear)                                  | Wi-Fi 6E                                                                                          | Wi-Fi 7                                                                                                                    | ✗                                                                                               | Wi-Fi 6E                                                                                          |
| USB-C (rear)                                  | 1 x USB 3.2 Gen 2x2, 1 x USB 3.2 Gen 2                                                            | 2 x Thunderbolt/USB 4 1 x USB 3.2 Gen 2x2                                                                                  | ✗                                                                                               | 2 x Thunderbolt/USB 4                                                                             |
| USB-A (rear)                                  | 2 x USB 2, 4 x USB 3.2 Gen 2                                                                      | 2 x USB 3.2 Gen 1                                                                                                          | 4 x USB 3.2 Gen 2                                                                               | 6 x USB 3.2 Gen 2                                                                                 |
| Audio (rear)                                  | 3 x 3.5mm audio jack, 1 x optical S/PDIF                                                          | 5 x 3.5mm audio jacks, 1 x optical S/PDIF                                                                                  | 1 x 3.5mm audio jack                                                                            | 5 x 3.5mm audio jacks                                                                             |
| USB (front)                                   | 1 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                          | 4 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                                                   | 4 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                        | 2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                          |
| Audio (front)                                 | ✗                                                                                                 | 1 x 3.5mm audio jack, 1 x 3.5mm microphone jack                                                                            | 1 x 3.5mm audio jack, 1 x 3.5mm microphone jack                                                 | 1 x 3.5mm combo audio jack                                                                        |
| Software                                      |                                                                                                   |                                                                                                                            |                                                                                                 |                                                                                                   |
| Operating system                              | Windows 11 Pro 64-bit                                                                             | Windows 11 Pro 64-bit                                                                                                      | Windows 11 Pro 64-bit                                                                           | Windows 11 Pro 64-bit                                                                             |

\*As you can't buy this system with an RTX 4080 in the UK, the price assumes you choose an RTX A4000 card instead.





| RECOMMENDED                                                                                                                                         |  | £10,000 SYSTEMS                                                                                                         |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------------------|--|
| Scan 3XS GWP A1-R24                                                                                                                                 |  | LABS WINNER – £10,000                                                                                                   |  |
| ★★★★★                                                                                                                                               |  | ★★★★★                                                                                                                   |  |
| £3,667 (£4,400 inc VAT)                                                                                                                             |  | £8,329 (£9,994 inc VAT)                                                                                                 |  |
| Free                                                                                                                                                |  | Free                                                                                                                    |  |
| scan.co.uk/3xs                                                                                                                                      |  | armari.com                                                                                                              |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| 3yr – 1st year on-site, 2nd and 3rd year RTB (parts and labour)                                                                                     |  | 3yr RTB (parts and labour, 1st year C&R)                                                                                |  |
| AMD Ryzen 9 9900X                                                                                                                                   |  | AMD Ryzen Threadripper 7980X                                                                                            |  |
| Asus ProArt B650-Creator                                                                                                                            |  | Asus Pro WS TRX50 Sage WiFi                                                                                             |  |
| 4 x RAM slots (2 free), 2 x PCI-E 4 x16 (1 free), 1 x PCI-E 4 x4 (1 free), 1 x PCI-E 4 x1 (1 free), 3 x M.2 sockets (2 free), 4 x SATA 600 (6 free) |  | 4 x RAM slots (0 free), 5 x PCI-E 5 x16 (4 free), 3 x M.2 sockets (1 free), 1 x U.2 (1 free), 8 x SATA 600 (8 free)     |  |
| 64GB/DDR5 6,000MHz                                                                                                                                  |  | 128GB/DDR5 5,600MHz                                                                                                     |  |
| PNY Nvidia RTX A4500 Ada Generation                                                                                                                 |  | AMD Radeon Pro W7800                                                                                                    |  |
| 24GB GDDR6                                                                                                                                          |  | 32GB ECC GDDR6                                                                                                          |  |
| 4 x DisplayPort 1.4                                                                                                                                 |  | 3 x DisplayPort 2.1, 1 x Enhanced Mini DisplayPort 2.1                                                                  |  |
| Corsair MP700                                                                                                                                       |  | Crucial T700                                                                                                            |  |
| 2TB                                                                                                                                                 |  | 2TB                                                                                                                     |  |
| NVMe M.2 PCI Express 5                                                                                                                              |  | NVMe M.2 PCI Express 5                                                                                                  |  |
| N/A                                                                                                                                                 |  | Crucial T700                                                                                                            |  |
| N/A                                                                                                                                                 |  | 2TB                                                                                                                     |  |
| N/A                                                                                                                                                 |  | NVMe M.2 PCI Express 5                                                                                                  |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| N/A                                                                                                                                                 |  | N/A                                                                                                                     |  |
| Fractal North Charcoal (215 x 447 x 469mm)                                                                                                          |  | Armari Magnetar M60G4 (220 x 565 x 465mm)                                                                               |  |
| Corsair RMX750 80PLUS Gold (750W)                                                                                                                   |  | 1650Watt Gold ATX 3.0 Gen5 fully Modular (1,650W)                                                                       |  |
| Corsair Hydro H150i Elite liquid cooler                                                                                                             |  | Armari Threadripper Enterprise 360mm AIO CPU liquid cooler (700W PBO)                                                   |  |
| 1 x 2.5GbE, 1 x 1GbE                                                                                                                                |  | 1 x 10GbE, 1 x 2.5GbE                                                                                                   |  |
| ✗                                                                                                                                                   |  | Wi-Fi 7                                                                                                                 |  |
| 2 x USB 3.2 Gen 2                                                                                                                                   |  | 1 x USB 3.2 Gen 2x2                                                                                                     |  |
| 2 x USB 2, 3 x USB 3.2 Gen 2                                                                                                                        |  | 2 x USB 2, 6 x USB 3.2 Gen 2                                                                                            |  |
| 5 x 3.5mm audio jacks, 1 x optical S/PDIF                                                                                                           |  | 2 x 3.5mm audio jacks, 1 x optical S/PDIF                                                                               |  |
| 2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                                                                            |  | 2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                                                |  |
| 1 x 3.5mm audio jack, 1 x 3.5mm microphone jack                                                                                                     |  | 1 x 3.5mm audio jack, 1 x 3.5mm microphone jack                                                                         |  |
| Windows 11 Pro 64-bit                                                                                                                               |  | Windows 11 Pro 64-bit                                                                                                   |  |
|                                                                                                                                                     |  | PCSpecialist Zircon Extreme                                                                                             |  |
|                                                                                                                                                     |  | RECOMMENDED                                                                                                             |  |
|                                                                                                                                                     |  | Scan 3XS GWP A1-TR64                                                                                                    |  |
|                                                                                                                                                     |  | ★★★★★                                                                                                                   |  |
|                                                                                                                                                     |  | £8,333 (£10,000 inc VAT)                                                                                                |  |
|                                                                                                                                                     |  | Free                                                                                                                    |  |
|                                                                                                                                                     |  | pcspecialist.co.uk/reviews                                                                                              |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | 3yr C&R parts and labour                                                                                                |  |
|                                                                                                                                                     |  | AMD Ryzen Threadripper Pro 7975WX                                                                                       |  |
|                                                                                                                                                     |  | Asus Pro WS WRX90E Sage SE                                                                                              |  |
|                                                                                                                                                     |  | 8 x RAM slots (4 free), 7 x PCI-E 5 x16 (6 free), 4 x M.2 sockets (3 free), 2 x SlimSAS (2 free), 4 x SATA 600 (3 free) |  |
|                                                                                                                                                     |  | 256GB/DDR5 4.800MHz ECC Registered                                                                                      |  |
|                                                                                                                                                     |  | AMD Radeon Pro W7900                                                                                                    |  |
|                                                                                                                                                     |  | 48GB ECC GDDR6                                                                                                          |  |
|                                                                                                                                                     |  | 3 x DisplayPort 2.1, 1 x Enhanced Mini DisplayPort 2.1                                                                  |  |
|                                                                                                                                                     |  | Samsung 990 Pro                                                                                                         |  |
|                                                                                                                                                     |  | 4TB                                                                                                                     |  |
|                                                                                                                                                     |  | NVMe M.2 PCI Express 4                                                                                                  |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | Seagate IronWolf Pro                                                                                                    |  |
|                                                                                                                                                     |  | 10TB                                                                                                                    |  |
|                                                                                                                                                     |  | 7200rpm                                                                                                                 |  |
|                                                                                                                                                     |  | ✗                                                                                                                       |  |
|                                                                                                                                                     |  | 256MB                                                                                                                   |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | Corsair MP700                                                                                                           |  |
|                                                                                                                                                     |  | 4TB                                                                                                                     |  |
|                                                                                                                                                     |  | NVMe M.2 PCI Express 5                                                                                                  |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | N/A                                                                                                                     |  |
|                                                                                                                                                     |  | Fractal Define 7 XL Black (240 x 604 x 566mm)                                                                           |  |
|                                                                                                                                                     |  | Corsair RMx Series Modular 80 Plus Gold (1,000W)                                                                        |  |
|                                                                                                                                                     |  | Enermax Liqtech TR4 II 360mm liquid cooler                                                                              |  |
|                                                                                                                                                     |  | Silverstone SST-XE360-TR5 liquid cooler                                                                                 |  |
|                                                                                                                                                     |  | 1 x 10GbE, 1 x 2.5GbE                                                                                                   |  |
|                                                                                                                                                     |  | ✗                                                                                                                       |  |
|                                                                                                                                                     |  | Wi-Fi 7                                                                                                                 |  |
|                                                                                                                                                     |  | 1 x USB 3.2 Gen 2x2                                                                                                     |  |
|                                                                                                                                                     |  | 2 x USB 2, 6 x USB 3.2 Gen 2                                                                                            |  |
|                                                                                                                                                     |  | 2 x 3.5mm audio jacks, 1 x optical S/PDIF                                                                               |  |
|                                                                                                                                                     |  | 2 x USB-A 3.2 Gen 1, 1 x USB-C 3.2 Gen 2                                                                                |  |
|                                                                                                                                                     |  | 1 x 3.5mm audio jack, 1 x 3.5mm microphone jack                                                                         |  |
|                                                                                                                                                     |  | Windows 11 Pro 64-bit                                                                                                   |  |

# Six things to look for in a workstation

When making a four-figure or even five-figure investment, it pays to take a detailed approach to every step of your buying decision

**W**orkstations are the most powerful desktop PCs around, but budgetary constraints still apply. You need to choose your components wisely – and that means focusing your money on the workloads you generally perform. The good news: it's no longer necessary to compromise too much between systems that are biased towards real-time graphics display and those aimed at final output. However, you should still spend the most on the components that will benefit your workload the greatest.

## 1 Processor

Processors have moved on a generation since our last workstation Labs. The AMD Ryzen 9000 series arrived just in time for this test, when last year we had the previous 7000 series. Intel Core CPUs have moved from 13th (Raptor Lake-S) to 14th (Raptor Lake-S Refresh), and Threadripper Pro from 5000 to 7000 series. Most significantly for higher-end workstations, the non-Pro AMD Ryzen Threadripper is back, having skipped the 5000 series.

Intel hasn't increased the number of cores with the 14th generation. The top Core i9-14900 processors still have eight P performance cores, which support Hyper-Threading, and 16 E efficiency cores, which don't. This means they provide 32 threads, the same as a 16-core processor from AMD, but from 24 real cores, which makes for a good balance of capabilities between workloads that favour single and multithreaded environments.

The main difference between the 13th and 14th generations of Intel Core processors is a little more clock speed thanks to production optimisation. They're both manufactured using the 7nm-equivalent Intel 7 process. While 16 cores remain the pinnacle of the AMD 9000 series so far, the same as the 7000 series, this generation does come with "die shrink" from 5nm features to 4nm. With the AMD Ryzen 9000



**ABOVE** Your workload will determine what components you buy

**"If your workload is more optimised for multiple threads, the AMD Ryzen Threadripper is the primary choice"**

**BELOW** AMD's Ryzen 9000 chips arrived just in time for this Labs



series, therefore, the performance improvement is going to be more pronounced compared to the 7000 series (which our testing also implies), so make sure you get the latest CPU.

Both Intel and AMD mainstream processors are great for a range of activities, but if your workload is more optimised for multiple threads, the AMD Ryzen Threadripper is the primary choice. The Intel Xeon still hasn't made a comeback (see "What has happened to Intel processors?", p91). However, you can now choose between the Threadripper and its Pro variant. The latter has a wider range, going up to 96 cores and down to 12 cores, while the non-Pro is only available with 24, 32 and 64 cores. But for Pro and non-Pro CPUs with the same number of cores, the base and Boost frequencies are the same.

However, the Pro is significantly more expensive than an equivalent non-Pro, as are the motherboards supporting it, meaning you should only choose it if you need its additional features. The main ones here are support for

eight-channel memory, where the non-Pro is only quad channel, so in theory the Pro can offer twice the RAM bandwidth. The Pro also has 128 PCI Express 5 lanes versus 48 for the non-Pro, which also has 24 PCI Express 4 lanes. This means the Pro can support more peripherals running at the full x16 mode, such as multiple powerful GPUs and high-speed networking adapters. If you don't need these capabilities, the basic Threadripper is much more cost-effective, and we're glad to see it back on the market.

## 2 Memory

Last year, we were still at the tail end of the transition from DDR4 to DDR5. But now all the latest CPUs support DDR5 memory, which theoretically provides at least twice the bandwidth. There is some variation in the DIMM speeds supported, but that has less impact than the generation, the amount installed and how many channels are operated in parallel.

While we would still say 32GB is an absolute bare minimum amount of RAM for content creation work, 64GB is fast becoming the baseline. This month, only two systems came with just this amount, and the rest had more. The more memory the system has, the smoother your workflow will be with large 3D datasets or when working with huge images and 4K



video. Now that processors have so many cores, more RAM helps these run multiple applications simultaneously; for example, when encoding a finished video edit in the background while working on the next one.

Both Intel Core and AMD Ryzen processors offer dual-channel memory, so DIMMs should be installed in matched pairs. Motherboards for these processors will usually have four DIMM slots, although some mini-ITX boards only have two. Ryzen Threadripper supports quad-channel memory, so should have four matching DIMMs to take advantage of the performance benefits of this capability. Similarly, with Threadripper Pro's eight-channel support, eight matching DIMMs are required to enable the full bandwidth available. Buying a Threadripper Pro system and not using its eight-channel memory facility is missing out on one of the unique features you paid extra for.

### 3 Graphics acceleration

Most content creation will require live rendering of design work. If any of this involves 3D, such as film or TV animation, CAD, engineering or product design, you're going to need a fast graphics accelerator. Professional GPUs are more expensive than consumer-grade ones, and for some types of activity the latter might be a valid choice. For example, game developers may want to test their designs on the same PC they use for creation, so having a gaming card makes sense.

However, professional graphics card ranges generally have longer warranties and come with specific support for professional software. They will also be optimised for this software. A particularly telling example is Siemens NX, which runs very slowly on consumer-grade GPUs with gaming drivers. Surprisingly, although all the systems on test this month support PCI-E 5 peripherals, none of the current generation of graphics cards requires this.

Although the performance competition between AMD and Nvidia continues, only three of the systems this month came with Radeon Pro accelerators, while the rest had Nvidia RTX and GeForce cards. This shows that AMD is continually facing difficulties gaining share in the professional workstation space, although its Instinct accelerators are finding favour further up the market.



**ABOVE** Most of the systems on test came with Nvidia RTX and GeForce cards

The Nvidia RTX 4000 Ada Generation is a solid baseline for high-end professional acceleration for content creation, costing around £1,300. The 4500 Ada Generation is around £2,500, so you pay a lot more for this increment in performance, while the 5000 Ada Generation is around £4,200. The AMD Radeon Pro W7800 also costs £2,500, and offers similar performance to the 4500, while the W7900 is over £3,800. It

can beat the Nvidia RTX 5000 Ada Generation in some tests.

There's no definitive overall answer to the question whether AMD or Nvidia are better choices for professional graphics.

It's best to pinpoint what your main visualisation workloads will be, look at the benchmarks, and choose which is generally best for those activities within the price range you can afford.

However, the incredible power of GPUs is increasingly being harnessed for other activities. They're so good at rendering 3D in real-time that it's no surprise that they can be very quick at outputting 3D animation frames, too. But they also have a part to play in the current AI revolution. We've dipped our toes in this water with

one test of this capability, but expect it to grow in value soon. Watch this space.

### 4 Storage

Most workstations in the past used to combine a fast boot-up and application drive with cheaper secondary storage for data. However, as the capacity of super-fast SSDs has increased and their cost gone down, this is less of a necessity, and not all systems this month

provide more than one storage device. If you work with massive video files, you will still want a lot of capacity. But otherwise, a 2TB drive will keep things going and a 4TB one will be adequate for a long time.

The latest PCI-E 5 NVMe M.2 SSDs can deliver well over 10,000MB/sec reading speeds, and often surpass this for writing. Even the quickest SATA conventional hard disks will provide around 40 times lower throughput. They still offer the most capacity

for the money, and if you need more than 4TB then flash storage is going to be extremely expensive. A sensible way of working these days is having enough flash storage in your system for a few projects, and then use a large USB-C-attached external device as backup. Archiving and retrieval may take a little time, but your workflow will be rapid on the system itself.

### 5 Chassis

There isn't a bad chassis in evidence this month. The Fractal Design Meshify that was popular last year has surprisingly disappeared, but we still have a couple of Fractal Define 7 cases. These have an unassuming appearance but are well made. The Fractal North variants used by Scan look fantastic, as does the tiny Phanteks Evolv Shift XT supplied by Armari. The latter has also delivered one of its own-brand chassis, which is purpose-built for workstation applications. Lenovo's chassis is also well made for easy maintenance. However, the main thing to look for is whether there are enough drive mounts should you need to add more storage. Armari's case provides easy-fit caddies for this, making it particularly well endowed in this area.

### 6 Power supply

The final component to consider for a workstation is the power supply. These are performance-oriented systems, and they eat watts for breakfast, so you need to be sure that your PSU can cope. A 750W supply is a bare minimum in these days of power-hungry CPUs and GPUs. For a Threadripper system, we recommend over 1,000W. Also take note of efficiency. At least Gold is essential, and Platinum even better. This indicates that very little power will be lost converting from 240V AC to the various DC feeds within the computer. ➔

**BELOW** The Fractal North chassis used by Scan looks fantastic



# How we test and benchmark results

To help you make the right decision, we put the workstations through a variety of tests

We run our *PC Pro* real-world benchmarks suite to assess image-processing and video-encoding abilities, then multitasking (see results on p95). Each category's score indicates relative speed compared to a Core i7-4760K desktop PC with 8GB of RAM. If a machine scores 150 in a test, it's 50% faster than the reference PC. All these results are then combined into an overall score.

Our other tests focus on higher-end workstation tasks. To test 3D modelling, we use SPECviewperf 2020 v3.1, which runs OpenGL and Direct3D viewsets (here, viewsets means a particular set of workloads designed to replicate real-world tasks) based on popular 3D content creation, engineering and

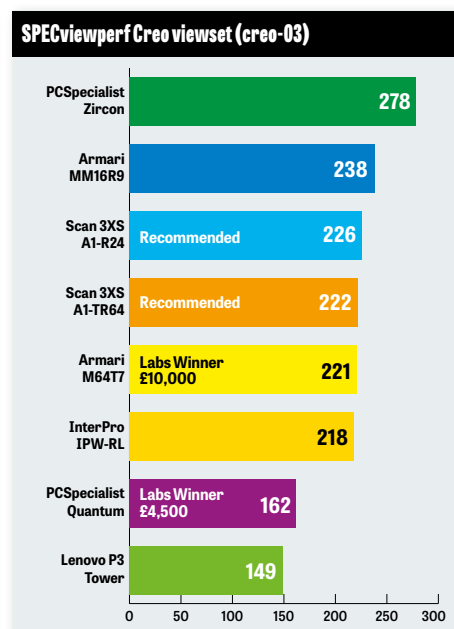
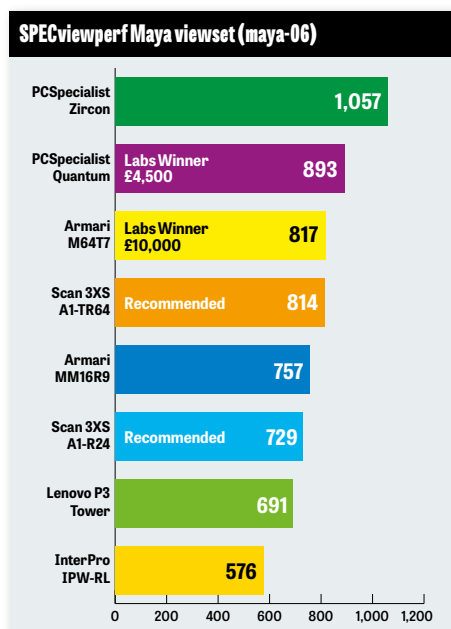
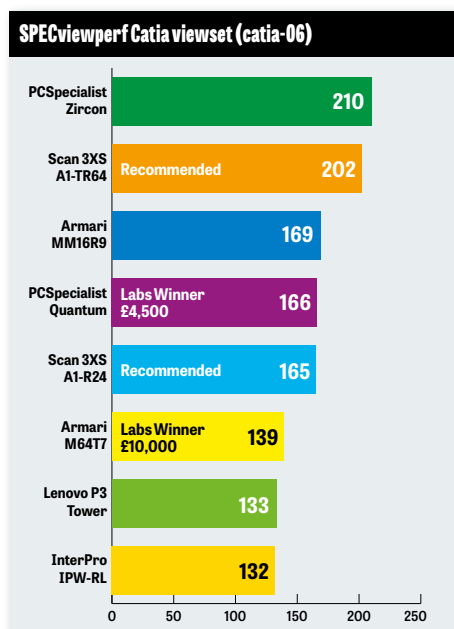
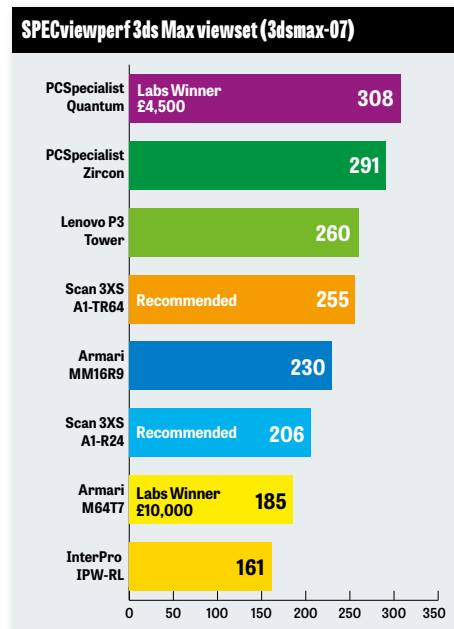
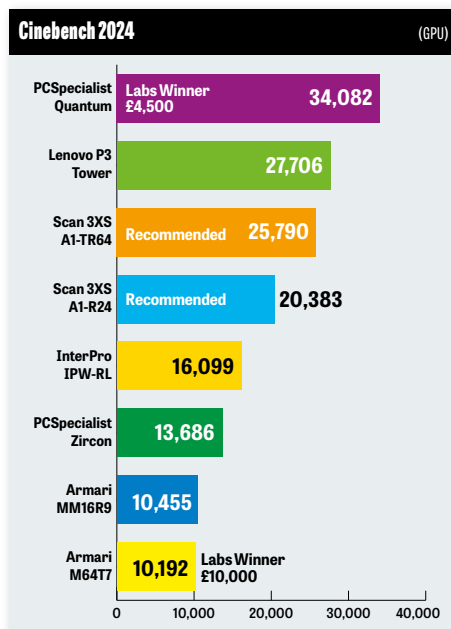
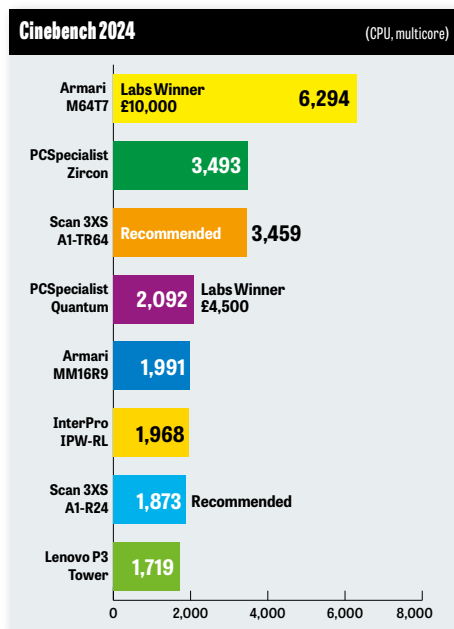
medical applications. These include Autodesk 3ds Max and Maya, PTC's Creo, Siemens NX, plus Dassault Systèmes Catia and SolidWorks.

Maxon Cinebench 2024 contains a 3D rendering test that is run on the GPU, a single CPU core and then across all available CPU threads, to show how much multithreaded performance the system has to offer. We also test CPU 3D rendering using Blender 4.2 and a frame from the Cosmos Laundromat animated movie, codenamed Project Gooseberry. This is a gruelling, lengthy render that really taxes cooling and can cause core throttling if this isn't sufficient. GPU rendering is slowly becoming used in live production, so we test GPU-accelerated 3D rendering with the

OpenCL-powered Luxmark 3.1. We also test GPU rendering with the same Blender frame, using CUDA acceleration for Nvidia cards and HIP for AMD ones.

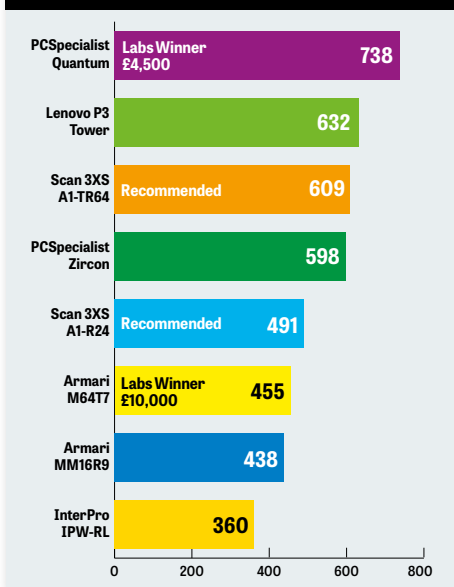
To assess video encoding, we render the Blender *Tears of Steel* movie from UHD (3,840 x 2,160) to 4K using H.264 compression. For this test, we employed Adobe Media Encoder CC 2024, and ran the encode with GPU acceleration both enabled and disabled. We also tested the raw performance of SSDs and hard disks with the CrystalDiskMark 8.0.5 benchmark.

A new test this year is machine learning inferencing, which we assess using Geekbench ML 0.6. This runs a series of inferencing tests using the ONNX platform on the CPU and on the GPU via DirectML.

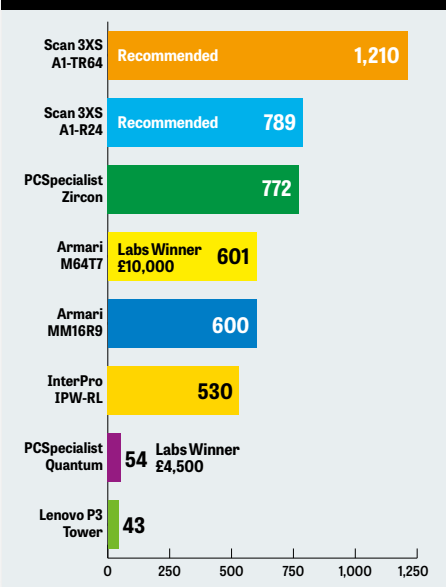




### SPECviewperf SolidWorks viewset (solidworks-07)

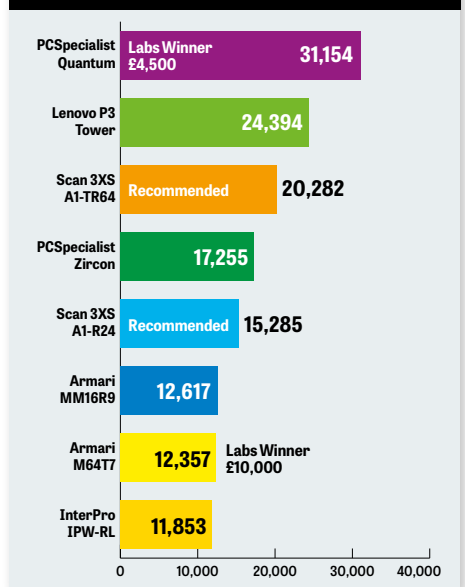


### SPECviewperf Siemens NX viewset (snx-04)

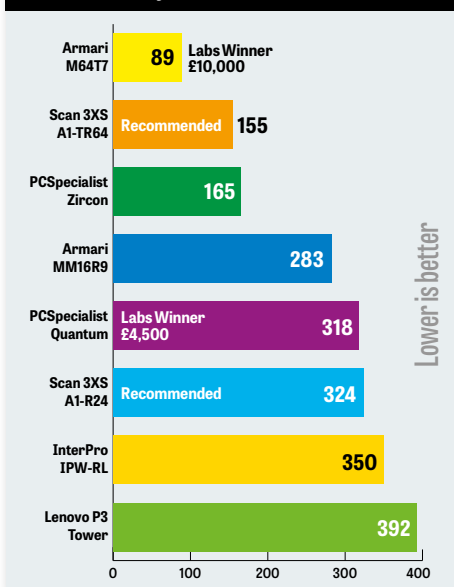


### LuxMark 3.1

(Hotel Lobby OpenCL)

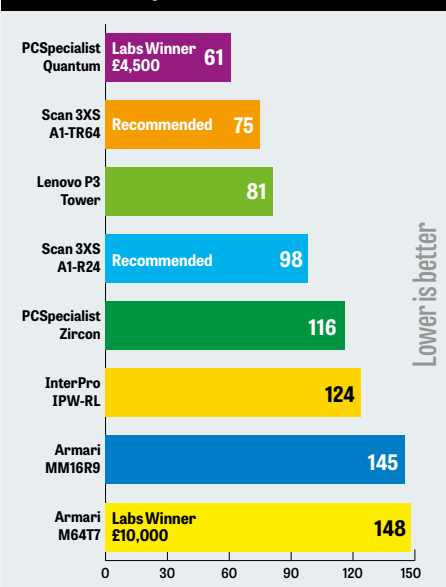


### Blender Gooseberry CPU



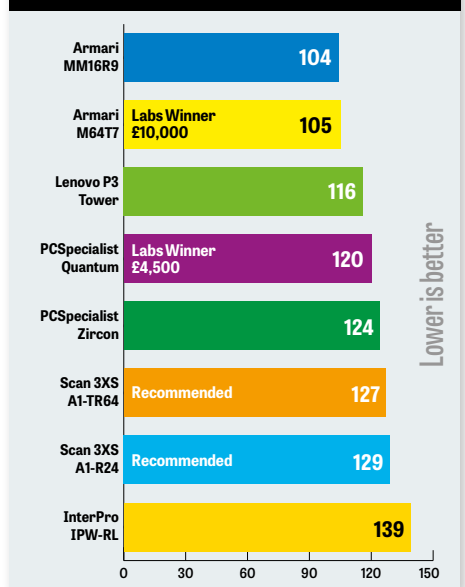
### Blender Gooseberry GPU

(seconds)



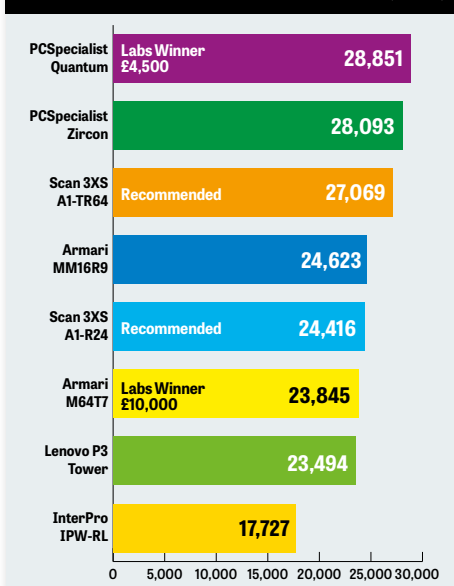
### Tears of Steel 4K

(CUDA/OpenCL secs)



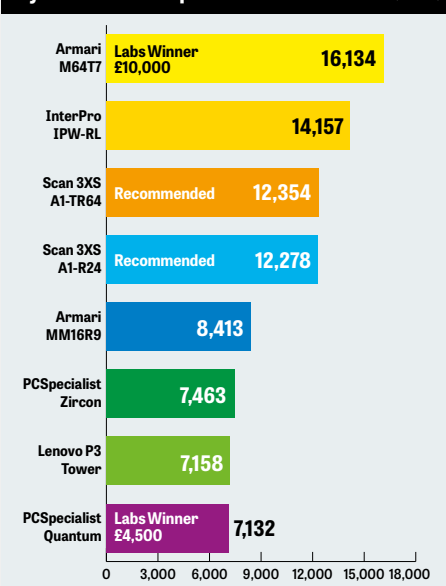
### Geekbench ML 0.6

(DirectML)



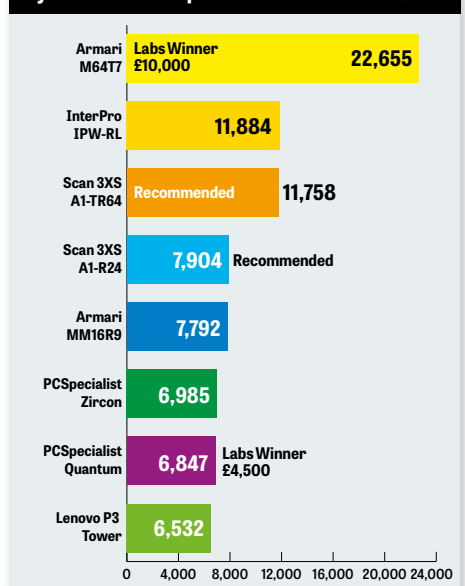
### CrystalDiskMark 8 sequential read

(MB/sec)



### CrystalDiskMark 8 sequential write

(MB/sec)





## ARMARI MAGNETAR PRMM16R9

A tiny system that looks great and performs well beyond what you'd expect from a workstation this small

SCORE ★★★★★

PRICE £3,749 (£4,499 inc VAT)  
from armari.com

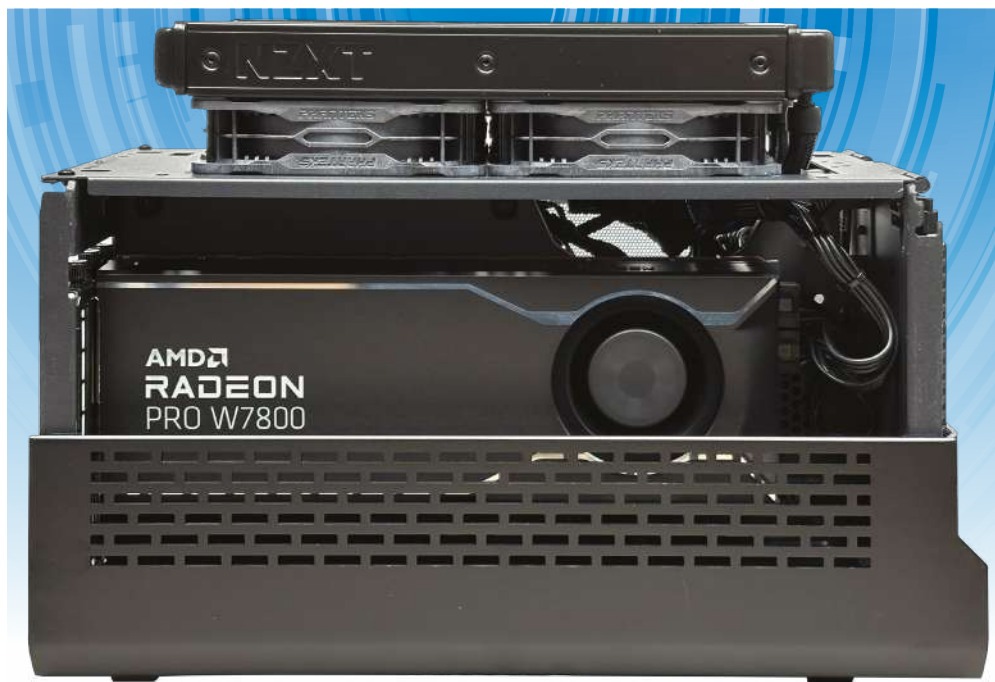
**A**rmari decided to provide us with something a little different for its £4,500 workstation entry this year. Instead of the classic black box like something out of 2001: *A Space Odyssey*, the Magnetar PrMM16R9 is small – very small. Yet it packs in the same workstation-grade components found in more conventional systems.

The Magnetar uses a Phanteks Evolv Shift XT chassis, which is a quarter to a third smaller in every dimension than other cases this month. The physical appearance with angled corners is stylish, but the infinity mirror on the front is mesmeric, looking like a lit passageway extending unfeasibly into the front of the case. This is a chassis you'll want to display on your desk as a statement rather than hiding it below. Yet it still sports a 240mm liquid-cooling system for the CPU and an 850W PSU. Although there's not much room for extra storage in a case this small, the only avoidable downside is that there are no USB or audio ports on the front.

There was a hope that this system could be supplied with the AMD Ryzen 9 9950X, but this member of the new 9000-series wasn't quite ready for testing at the time of writing. Instead, Armari sent this system with the previous-generation 7950X, but it will ship the final version with the 9950X for the price quoted above. The 7950X provides the same 16 cores as the 9950X, running at a base 4.5GHz with a 5.7GHz boost, whereas the 9950X will have the same boost frequency but an improved core design.

Armari partners the Ryzen 9 with a hefty 96GB of 5,600MHz DDR5 memory, supplied as two 48GB modules. This takes up both DIMM slots on the Asus ROG Strix B650E-I Gaming WiFi motherboard, but you probably won't want more in a small system such as this one.

Despite its size, the PrMM16R9 has room for a dual-width graphics card,



**ABOVE** The diminutive Magnetar packs an incredible amount of power into its tiny case

in this case the AMD Radeon Pro W7800. It could, apparently, take an even wider accelerator such as the triple-width W7900. The W7800 sports 4,800 Stream Processors and 32GB of GDDR6 memory delivering 576GB/sec of bandwidth.

Another surprising inclusion for such a diminutive system are the two storage drives. The main one is a 2TB Crucial T705 NVMe M.2 device, with a PCI Express 5 interface. This delivered 8,413MB/sec sustained reading and 7,792MB/sec writing using CrystalDiskMark 8. Then there's a secondary 2TB Kioxia Exceria Pro NVMe drive running at PCI Express 4 speeds and providing 7,095MB/sec reading alongside 3,218MB/sec writing speeds.

Although the Magnetar's AMD Ryzen 9 7950X is the previous CPU generation now, it packs a punch. An overall score of 729 in the *PC Pro* media benchmarks still beats the InterPro's Core i9-14900K CPU, with

solid results of 289 in image editing, 692 in video encoding and 901 in multitasking. The multi-CPU render result with Maxon Cinebench 2024 of 1,991 is also slightly faster. The Blender Gooseberry frame took 283 seconds, which surpassed all the other systems in the £4,500 class. Considering the performance of the 12-core Ryzen 9000 series used by Scan, with the 9950X in this system instead of the 7950X, the results would be very competitive indeed.

The AMD Radeon Pro W7800 performs well. In SPECviewperf 2020, results of 230 in 3dsmax-07 and 757 in maya-06 show excellent 3D animation modelling ability. And 169 in catia-06, 238 in creo-03 and 600 in snx-04, with a decent 438 in solidworks-07, imply capable CAD and engineering abilities. The AI inference score of 24,623 in the Geekbench ML, 12,617 with LuxMark 3.1 OpenCL, and Blender Gooseberry frame of 145 seconds

are about what we'd expect from this GPU.

With our review sample relying on a previous-generation AMD Ryzen, the Armari Magnetar PrMM16R9 couldn't win this Labs test; although the upgrade will be at no extra cost by the time you read this, we can't confirm the performance until we try it. But this is still a great-looking compact system that punches way above its size. It has plenty to commend it to anyone looking for a stylish yet powerful desk-friendly workstation.

**BELOW** The mirror on the front is mesmeric, and the rear is packed with ports





## INTERPRO IPW-RL

A solid, well-rounded workstation specification, but there are faster systems this month

SCORE ★★★★★

PRICE £3,642 (£4,370 inc VAT)  
from ipworkstations.com

**B**ritish workstation specialist InterPro has quietly been delivering excellent systems for over two decades now, and the IPW-RL is another case in point. The system combines a sensible selection of components for general content-creation tasks, and backs it up with a huge amount of memory.

The CPU choice is from Intel's stable, but not the absolute pinnacle of the range. It's the latest 14th generation, but the Core i9-14900K rather than the slightly faster KS variant. Both CPUs combine eight P performance cores with 16 E efficiency ones, offering base clocks of 3.2GHz and 2.4GHz respectively. However, the K processor has a 5.8GHz P-core maximum Turbo Boost frequency and 6GHz Thermal Velocity Boost, versus 5.9GHz and 6.2GHz respectively for the KS. The E-cores can only hit 4.4GHz with the K versus 4.5GHz for the KS.

What InterPro has saved on the processor has clearly been put towards memory, with 48GB 5,200MHz DDR5 DIMMs filling all four slots on the Asus ROG Maximus Z790 Dark Hero motherboard, for a massive total of 192GB. You're unlikely to need more RAM for the lifetime of this machine.

Graphics acceleration is sensible for this price point, coming in the form of a PNY Nvidia RTX 4000 Ada Generation card. This sports a whopping 6,144 CUDA cores and 20GB of ECC-protected GDDR6 memory with 360GB/sec bandwidth. The 4000 series is the everyday workhorse of the Nvidia RTX professional range, offering a sensible balance between potency and price.

InterPro also gives you everything you need when it comes to storage. The main system drive is a 2TB Crucial T705 NVMe M.2 PCI Express 5 unit offering blistering 14,157MB/sec sustained reading and 11,884MB/sec writing, according to CrystalDiskMark 8. The secondary 4TB Crucial P3 Plus drive is also an NVMe M.2 unit, but uses a PCI Express 4 bus so delivers more modest sustained reading of

4,783MB/sec, with writing recorded at 4,365MB/sec. That's going to be more than capable both in terms of speed and capacity for throughput-sensitive tasks such as editing high-resolution video.

All these components are integrated into a Fractal Design Define 7 chassis, a regular sight in the PC Pro workstation Labs over the years. InterPro has chosen the Compact version, which can accommodate two 3.5in or 2.5in drives and up to four 2.5in drives on top of that. This solid black machine has been equipped with a 1,000W Corsair RM1000e V2 PSU, with a 360mm Corsair iCue H150e RGB Elite liquid-cooling system for the CPU.

On an absolute scale, the InterPro's components are potent, but in this month's Labs company it falls behind in most areas. The overall PC Pro media benchmark score of 716 would have been a Labs-winning total a few years ago – as would the individual results of 297 for image editing, 649 for video encoding and 901 for multitasking – but it was the slowest overall this month. The Cinebench 2024

**ABOVE** The IPW-RL combines sensible components with a huge 192GB of RAM

**BELOW** The Fractal Design Define 7 chassis is a regular in the PC Pro Labs

multi-CPU rendering score of 1,968 only beats the 12-core Scan system. The Blender render test took 350 seconds on CPU, which was beaten by the 12-core Scan machine.

The SPECviewperf 2020 results are similarly adequate for most tasks, but every other system here includes more powerful GPU acceleration. The scores of 161 in 3dsmax-07 and 576 in maya-06 demonstrate excellent 3D modelling animation abilities, while 132 in catia-06, 218 in creo-03, 530 in snx-04 and 360 in solidworks-07 will be great for engineering, CAD or product design. But there are even better scores in this test.

If you use this Nvidia GPU for rendering or AI inference, it also falls behind other systems, taking 124 seconds for the Blender render using CUDA, delivering just 11,853 in LuxMark 3.1 and producing 17,727 in the Geekbench ML 0.6 AI benchmark. Overall, while this is a very capable workstation that would make light work of most real-time content creation or output rendering tasks, there are alternatives this month that provide more in either department.





## LENOVO THINKSTATION P3 TOWER

Underspecified but affordable compared to rivals, so worth considering if you want a dependable Tier 1 brand

SCORE ★★★★★

PRICE With RTX A4000 graphics, £2,783 (£3,339 inc VAT) from [lenovo.com](https://www.lenovo.com)

Lenovo, as the heir to IBM's PC business, has a long and illustrious history of producing incredible workstation designs. The P3 Tower is the latest in the line of mid-sized tower systems, with a solid construction and labour-saving features.

However, the version we were sent came with a 13th generation Intel Core i9 processor, one behind other Intel-based systems this month, even though this system can be specified with the 14th generation. At least it's a near range-topping 13900K, which has eight performance P-cores with Hyper-Threading and 16 efficiency E-cores without it. The P-cores have a base 3GHz clock and top Thermal Velocity Boost of 5.8GHz. The E-cores have a base 2.2GHz frequency with 4.3GHz boost. There is a KS version that's a little faster still, but there's not a huge amount in it – and Lenovo only supplies this workstation with vPro chips anyway.

Lenovo has backed the Intel CPU with 64GB of 4,400MHz DDR5 RAM, supplied as two modules. This leaves two DIMM slots free to upgrade to the 128GB maximum. The Lenovo P3 chassis has some well-thought-out design elements, such as the two 120mm fans extracting air directly from the graphics card, and the side caddy for a 3.5in drive. Lenovo has also chosen the 1,100W PSU option for this system, which is sensible considering the graphics card.

Our sample P3 was equipped with an Nvidia GeForce RTX 4080 card, a hefty three-slot GPU drawing up to 450W on its own. However, this is a German model, while the UK configurator for the P3 only offers Nvidia RTX professional options. The price above assumes you opt for an RTX A4000 in the configurator, but an RTX A4500 would add £650 inc VAT to the price.

Lenovo has included two 1TB storage devices rather than a single 2TB unit. Both drives are catchily named SK Hynix HFS001TEJ9X102N

M.2 NVMe SSDs running at PCI Express 4 speeds. They deliver a quick sustainable reading rate of 7,158MB/sec, though in this month's company it's one of the slowest SSDs. Writing rates were 6,532MB/sec for one drive and 6,784MB/sec for the other, which are fast, but most SSDs are faster in this test.

Despite the 13th generation Intel Core i9, the Lenovo is far from a slow system. The overall score of 683 in the PC Pro media benchmarks is good compared to systems we've tested in the past, but the slowest this month. The image-editing score of 281 is better than the PC Specialist Zircon, but 605 in video editing and 869 in multitasking are the lowest on test. The multicore Maxon Cinebench 2024 result of 1,719 is also behind every other workstation, as is the Blender Gooseberry frame time of 392 seconds. CPUs have clearly moved on since Intel's last iteration. But you can buy this workstation with the latest from Intel if you need better CPU performance – and it will cost a mere £10 extra.

The consumer-grade graphics card, as usual, has strengths and weaknesses. Game designers and 3D animators will get smooth frame rates, as evidenced by



**ABOVE** Lenovo's P3 Tower isn't the most powerful, but comes in well under budget

**BELOW** The Lenovo P3 case is a well-designed chassis, with two fans for the graphics card

SPECviewperf 2020 results of 260 in the 3ds Max viewset and 691 in Maya. Some CAD, product design and engineering applications will also run smoothly. The Catia score of 133 is decent, 632 in the SolidWorks viewset is brilliant, but 149 in Creo is a little below par. The biggest problem is 43 in the Siemens NX viewset; you'll see far superior results if you buy this a card from Nvidia's professional RTX range instead. But the GPU has a lot of brute power, delivering a very healthy AI inference score of 27,706 in Geekbench ML, 24,394 in the LuxMark 3.1 OpenCL render, and the Blender Gooseberry frame took only 81 seconds to output using CUDA.

The Lenovo ThinkStation P3 Tower was never going to win any performance benchmarks this month with its previous-generation CPU and consumer graphics. However, Lenovo also hasn't used anywhere near the £4,500 inc VAT budget, with this system nearly £1,200 below that figure – and that even includes a keyboard and mouse. You could upgrade to the latest Intel CPU and RTX A4500 graphics and still have plenty of change. With the dependable Lenovo chassis design, this is a fine workstation that's well worth considering.





## PCSPECIALIST QUANTUM GOLIATH R

Its consumer graphics isn't suited to every workload, but this is a potent design workstation for the money

SCORE ★★★★★

PRICE £3,750 (£4,500 inc VAT)  
from [pcspecialist.co.uk/reviews](https://pcspecialist.co.uk/reviews)

**P**CSpecialist's Quantum Goliath R is an outlier in this group test, as one of two systems supplied with consumer-grade rather than professional graphics. But that doesn't mean it's just a gaming PC. Certain types of content creators – particularly game developers – prefer this anyway.

The GPU in question is an incredibly potent Asus TUF GeForce RTX 4090 OC Edition. This sports 16,384 CUDA cores, which is almost as many as the Nvidia RTX 6000 Ada Generation and more than any other Nvidia card here. There's 24GB of GDDR6X memory with 1,008GB/sec of bandwidth, which is also the highest in the Labs.

PCSpecialist has also gone for the best with the CPU, an Intel Core i9-14900KS. That's one rung up from the 14900K provided by InterPro. The 14900KS similarly provides eight P-cores (with multithreading) and 16 E-cores (without) and has the same 3.2GHz base clock for the P-cores, with 2.4GHz for the E-cores. However, the P-cores go all the way up to 6.2GHz in Thermal Velocity Boost mode, compared to 6GHz for the 14900K, and the E-cores will hit 4.5GHz instead of 4.4GHz.

The memory allocation is also surprisingly high for a system in this price bracket – 192GB in total, made up of four 48GB DDR5 DIMMs running at 5,200MHz. That leaves no room for upgrades on the Asus ProArt Z790-Creator WiFi motherboard, but you won't need to anyway.

Like PCSpecialist's more expensive entry this month, the Quantum Goliath R opts for a fast boot drive and slower but more capacious data drive. In fact, they're the same drives as the Zircon Extreme. The 4TB Samsung 990 Pro NVMe M.2 device for operating system and apps runs at PCI Express 4 speeds to deliver sustained reading of 7,132MB/sec and sustained writing of 6,846MB/sec with CrystalDiskMark 8. The larger 10TB data drive is a Seagate IronWolf Pro, aimed at business-grade use. This 7,200rpm SATA disk provides reading at 268MB/sec and

writing at 264MB/sec – fast for a mechanical disk but pedestrian compared to any SSD.

These components are integrated into a Corsair 5000D Airflow chassis. This is a nice-looking case but relatively orthodox in design, with a tempered glass side. It's designed for maximum airflow (hence the name) and has mounts for up to four 2.5in SSDs and two 3.5in drives. PCSpecialist has included a 1,000W Corsair RMx Series PSU, which is reassuring considering how much electricity the graphics card on its own will draw at full pelt.

The Quantum Goliath R makes good use of its Intel Core i9's performance. The PC Pro media benchmarks score of 841 isn't far off that provided by the 32-core AMD Ryzen Threadripper systems this month, and way ahead of other PCs in the £4,500 price category. The image-editing result of 306 was second fastest, while 816 in video encoding was only beaten by the monster 64-core Armari system. A multitasking score of 1,035 was very close to 32-core systems. With 24 cores and 32 threads, the Core i9 managed only 2,092 in Maxon Cinebench 2024

**ABOVE** Powerful components make this system the pick of the £4,500 workstations



**BELOW** The Corsair 5000D Airflow chassis is designed for maximum airflow



multi-CPU rendering, but that was the best in this price category, although the Blender Gooseberry render took 318 seconds, notably behind Armari's £4,500 system.

The consumer-grade graphics have strengths and weaknesses. With the 3D animation workloads in SPECviewperf 2020 it flies, delivering 308 in 3dsmax-07 and 893 in maya-06. However, it's not so great for CAD or engineering. While 166 in catia-06 and 162 in creo-03 are good, and 738 in solidworks-07 is superb, 54 in snx-04 is about ten times slower than a professional card.

The GPU compute tests show the full power of this accelerator, however, with a massive 34,082 in the Geekbench ML AI inference test and 31,154 with LuxMark 3.1 OpenCL. The Blender Gooseberry frame rendered in just 61 seconds with CUDA, which is the quickest we've ever seen.

The PC Specialist Quantum Goliath R is best avoided with this graphics choice if you run Siemens NX software. But if you're a game developer, SolidWorks CAD creative or 3D animator, the performance, huge memory and capacious storage make it highly recommended.





## SCAN 3XS GWP A1-R24

A promising first outing for the Ryzen 9000 series, with a 12-core chip that keeps up with 16- and 24-core rivals

SCORE ★★★★★

PRICE £3,667 (£4,400 inc VAT)  
from scan.co.uk

**A**MD was just in the process of launching its Ryzen 9000 Series processors as we were putting this Labs test together, and we've managed to squeeze our first look into the roundup. It comes from Scan in the form of the 3XS GWP A1-R24.

Just as the 14th generation of Intel Core CPUs don't make any radical changes over the 13th generation, the Ryzen 9000 doesn't diverge greatly on paper from the 7000 series, with core counts still ranging from six to 16. Even the clock rates haven't progressed. The AMD Ryzen 9 9900X in the Scan system is a 12-core CPU with a base 4.4GHz clock and 5.6GHz boost. The 7900X it replaces has a 4.7GHz base clock and 5.6GHz boost. The 16-core 9950X is similarly no on-paper leap over its 7950X predecessor.

However, the CPU is now produced on a 4nm process instead of 5nm, which should enable more cores to run closer to boost speeds than the previous generation. There's also support for 5,600MHz memory instead of 5,200MHz. Scan has gone even further, supplying 64GB of 6,000MHz DDR5 RAM as two 32GB DIMMs, leaving two slots free for upgrade on the Asus ProArt B650-Creator motherboard.

Scan has managed to go one better than the 4000-series Nvidia RTX graphics we would normally expect at this price and includes the 4500 Ada Generation instead. This sports 7,680 CUDA cores compared to 6,144 for the 4000, and 24GB of ECC-backed GDDR6 frame buffer operating at 432GB/sec, compared to 20GB at 360GB/sec.

The storage is more modest, however. Only one drive has been included, although it's a fast one. The 2TB Corsair MP700 NVMe M.2 unit operates at PCI Express 5 speeds to deliver an impressive sustained read speed of 12,278MB/sec in CrystalDiskMark 8, with sustained writing of 7,904MB/sec.



Scan has opted for the regular version of the Fractal North Charcoal chassis with the A1-R24. This is a stylish case with wooden slats down the front that make it look more like designer furniture than a PC. The chassis offers a couple of 2.5/3.5in drive mounts, and a couple of 2.5in-only ones, should you need to expand the storage. The PSU included is the 750W Corsair RMX750, which isn't hugely potent but should be enough for this set of components.

This system had the fewest cores of any entry this month – half as many as the Intel workstations – but it wasn't the slowest, showing the capability of the new Ryzen 9000 series. The PC Pro media benchmark result of 761 beat the 24-core Intel CPU supplied by InterPro and the 16-core AMD processor from the previous Ryzen generation in the Armari Magnetar PrMM16R9. This includes the best image-editing result this month of 359, competent video encoding of 716, and multitasking of 924, which wasn't far behind the 32-core systems in the test. The Cinebench 2024 multi-CPU rendering result of 1,873 was the slowest this month, but only 6% behind the Armari's Ryzen 9

**ABOVE** The new AMD Ryzen 9 9900X gives the Scan system plenty of punch



**BELOW** Wooden slats on the front of the case make it look more like designer furniture than a PC

7950X, which has a third more cores. Notably, the single-core Cinebench result was 16% faster. Similarly, the Blender Gooseberry frame render took 324 seconds, which sits in between the two 24-core Intel CPUs this month – despite having half the cores. This bodes well for the AMD Ryzen 9 9950X when it arrives.

The GPU-based performance from the Nvidia RTX 4500 Ada Generation unsurprisingly sits between the 4000 and 5000 we have in other systems. The SPECviewperf 2020 scores of 206 in 3dsmax-07 and 729 in maya-06 promise great 3D animation, while 165 in catia-06, 226 in creo-03, 789 in snx-04 and 491 in solidworks-07 mean CAD and engineering will be smooth. The Geekbench ML result of 24,416 means AI inference is midway between the other Nvidia cards, as is 15,285 with LuxMark 3.1 OpenCL.

With just 12 cores against systems boasting 16 or 24 in this price category, and 32 or 64 in the higher class, the Scan 3XS GWP A1-R24 acquits itself surprisingly well, showing that the AMD Ryzen 9000 series is a welcome upgrade over the 7000 series. Had this system included the 16-core Ryzen 9 9950X, it could have been our Labs Winner.





# What's happened to Intel processors?

Apart from a couple of Core i9 systems, Intel is conspicuous by its absence in this month's test – but there are greater woes looming for the market-leading CPU brand

**A**s we were putting this article together, a storm was brewing around Intel. The breaking story was that the 13th and 14th generation Core chips have a problem where they degrade over time and eventually fail. This is apparently due to “elevated operating voltage”. From what we can gather, with some processors, when the boost clock runs above a certain frequency for long periods it can lead to too much voltage being put through the chip, which eventually causes permanent damage.

It's a huge surprise that this is only now coming to light, considering the 13th generation hit the market two years ago. There were reports of PCs crashing as far back as December 2022, but it wasn't until the end of 2023 that the issues were found to be widespread. One game development studio, Alderon Games, which uses 13th and 14th gen Intel CPUs in its servers, claimed to be experiencing a 100% failure rate ([tinyurl.com/361alderon](https://tinyurl.com/361alderon)). Gamers seem to be the most badly affected, perhaps because their workloads push single cores to maximum boost, and they often overclock their CPUs.

Both 13th and 14th gen are variants of the same Raptor Lake design, so the technology is fundamentally related. How a second generation was released with the same problem before a fix was attempted is a shock for a company of Intel's age and pedigree. Intel provided a microcode update in August to try and fix the elevated voltages (see p10).

For the two systems in this month's test that came with Core i9 processors there should be nothing to worry about, because you'll be reading this after the microcode has been deployed. Unless, of course, the fix isn't sufficient to entirely solve the problem. What implication this will have for chip performance remains to be seen, because we hadn't seen the CPUs with the patch at the time of writing, but the impact is expected to be minimal.

## ■ Wider problems?

There's a wider question to be asked connected to this debacle. Is Intel in serious trouble? The company still has over \$20 billion in hand, so it's not going to go bankrupt any time soon. But the microcode update only prevents the issue from occurring on

new processors. It can't heal CPUs that have already become unstable. These will need to be replaced, which could cost Intel huge amounts and leaves the company open to lawsuits claiming additional compensation.

This doesn't bode well at a time when Intel is increasingly under pressure from its competitors. The company still has 63% of the x86 chip market. But we've seen AMD grow its share since the second half of 2019, when the Ryzen 3000 series, its Threadripper variant, and the second generation of Epyc started gaining market traction. Since then, AMD has gone from strength to strength, securing big wins with cloud service hyperscalers for Epyc.

This time last year we were expecting the Sapphire Rapids-WS Xeon to bring the fight back to AMD in the workstation market. This has arrived, with up to 56 cores per socket and a Turbo mode up to 4.8GHz. Early tests against the Ryzen Threadripper 5000 series were promising, giving the Xeon a performance lead. However, the 5000 series has been replaced by the 7000 series now, and there is no successor to Sapphire Rapids-WS yet.

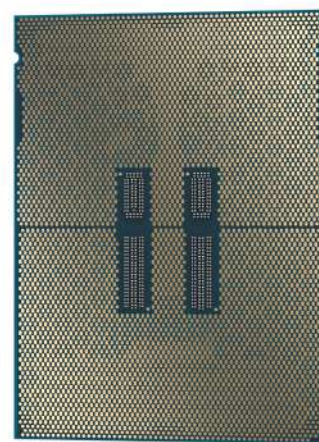
## ■ Server chips should be okay

With the current problems of the 14th generation Intel CPUs, there's a question over whether the same instability will be found in other new processor ranges. The Raptor Lake CPUs use Raptor Cove performance cores, which are also employed in Intel's 5th Generation Xeon Scalable processors aimed at data centres, codenamed Emerald Rapids (Sapphire Rapids uses the previous Golden Cove cores of 12th generation Intel CPUs). So far, there haven't been any reports of problems with Emerald Rapids on servers, however.

One theory we have is that these server CPUs don't push the individual core clock frequencies as much as processors used for gaming and game serving. Similarly, we've heard that workstation users of affected Intel CPUs haven't experienced instability. Heavy



**ABOVE** Intel's Xeon chips have struggled to compete with AMD



**“How a second generation was released with the same problem before a fix was attempted is a shock for a company of Intel's pedigree”**

**BELOW** Intel still uses a 10nm process on its 14th generation CPUs, while AMD is on 4nm

employment of multithreaded workloads will use a lower Boost across all cores rather than a higher Boost on one or two. For now, this is supposition as the causes of the problems continue to be explored.

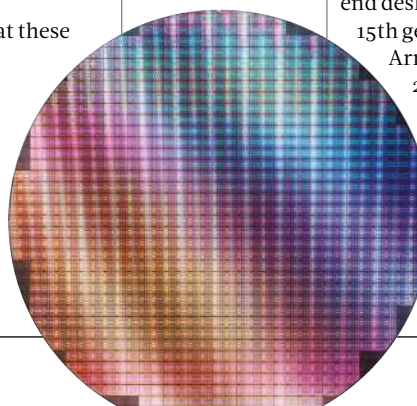
Either way, it's an incredible situation for Intel to be in, having been the dominant global workstation, desktop, laptop and server CPU vendor for so many years. It's a sign that the firm's supremacy as a microprocessor

manufacturer is under threat. The 14th generation Intel CPUs still use Intel 7, a 10nm manufacturing process with a similar transistor density to a 7nm process, whereas AMD is already

on 5nm with the Threadripper 7000 series and 4nm with the Ryzen 9000.

Perhaps the 6th generation of Xeon Scalable, codenamed Granite Rapids, will restore Intel's workstation fortunes. This will be arriving in 2024, and is destined to be produced using Intel 3, a process with a similar transistor density to 3nm, so the features will be even smaller than the AMD Ryzen 9000 series. At the high-end desktop end of the market, Intel's 15th generation CPU, codenamed

Arrow Lake, will use Intel 20A, a 2nm process. It will also have an updated Lion Cove performance core design, which hopefully will have the instability problems of Raptor Cove fixed for good. Perhaps then we'll see the return of Intel to its former levels of glory.





## ARMARI MAGNETAR M64T7-AW1650G4

Unbeatable CPU performance and solid GPU acceleration make this an extraordinarily capable workstation

SCORE ★★★★★

PRICE £8,329 (£9,994 inc VAT)  
from armari.com

**A**rmari has been a leader in the UK workstation market for decades and, together with Scan, is often the first to send us the latest technology. The Magnetar M64T7-AW1650G4 isn't the only system this month to sport one of the recently released non-Pro AMD Ryzen Threadrippers, but it's the only one to opt for the 64-core iteration.

The Threadripper 7980X has a base 3.2GHz clock across its 64 cores (with 128 threads) and a maximum boost of 5.1GHz. The most obvious difference between the two variants of the Threadripper is that the Pro version supports eight-channel memory, and the non-Pro variant has a quad-channel controller, so will have lower RAM bandwidth. However, the Pro also has 128 PCI Express 5 lanes whereas the non-Pro only offers 48, plus 24 PCI Express 4 lanes. So the Pro will support a greater number of fast peripherals, such as networking and GPUs. Unless you need the memory and peripheral bandwidth, the non-Pro is much cheaper and therefore more cost-effective.

Armari has taken advantage of the quad memory channels by providing four 32GB DDR5 DIMMs running at 5,600MHz, for a total of 128GB. This will be enough for now, although several manufacturers this month have provided a lot more. The Asus Pro WS TRX50 Sage WiFi motherboard supports up to 1TB of memory.

Although the vanilla Threadripper is cheaper than the equivalent Pro, it's still expensive, so Armari has been more conservative about its graphics acceleration choice. Instead of the range-topping AMD Radeon Pro W7900, the GPU is the W7800 that sits one rung below. This has 4,480 Stream processors instead of 6,144, and 32GB of GDDR6 frame buffer instead of 48GB, with 576GB/sec of bandwidth instead of 864GB/sec.

Also, while there are two storage drives in this system, Armari hasn't supplied a smaller, faster one for the operating system and applications

alongside a larger, slower one for media. Instead, there are two 2TB Crucial T700 M.2 NVMe devices operating at PCI Express 5 speeds. These have been combined using the motherboard's built-in array capability into a single 4TB RAID0 device. This configuration delivers a staggering 16,134MB/sec of sustained reading and 22,655MB/sec writing (as measured by CrystalDiskMark 8).

One of Armari's unique features is that it designs its own chassis and cooling solutions, although not for all its systems. The Magnetar M64T7-AW1650G4 sports the latest iteration of Armari's M60G4 case, which now has some unique airflow tunnelling but most significantly has custom liquid cooling warrantied to deliver 700W for AMD's Precision Boost Overdrive. Armari systems come with the latter enabled to obtain the maximum possible performance while remaining entirely reliable and stable. The chassis also has side-accessible easy-swap caddies for adding up to three 2.5/3.5in drives and another with a U.2 connection that supports SAS or up to three PCI Express 4 NVMe drives. The 1,650W PSU should be more than capable of supplying a fully stocked system without missing a beat, however.

**ABOVE** The Armari gave us some of the highest test results we've ever seen



**BELOW** Armari's M60G4 case provides custom water cooling



With that 64-core AMD Ryzen Threadripper CPU, the Armari was sure to dominate in most of the processor-focused benchmarks. The overall *PC Pro* media benchmark score of 949 is the highest we've seen, and although the image-editing result of 281 isn't top of the pack, 869 in video encoding and 1,224 in multitasking trounce the competition. Likewise, 6,294 in Cinebench 2024 multi-CPU rendering was more than three times faster than any of the £4,500 systems this month, and 80% quicker than anything else. It dispatched the Blender Gooseberry render in 89 seconds on CPU, way ahead of anything we've seen before. The Adobe Media Encoder OpenCL-enhanced render took only 105 seconds.

The GPU, however, is merely great rather than dominant. SPECviewperf 2020 results include 185 in 3dsmax-07 and 817 in maya-06, 139 in catia-06, 221 in creo-03, 601 in snx-04 and 455 in solidworks-07, showing 3D animation and engineering workloads will be dealt with easily. But the W7900 is significantly faster in all areas. GPU rendering and AI inference is similarly good but beaten by a few competitors. Overall, though, this is another incredible system from Armari, and a worthy Labs Winner.





## PCSPECIALIST ZIRCON EXTREME

A superb all-rounder, with great graphics acceleration, very fast rendering and plenty of storage

SCORE ★★★★★

PRICE £8,333 (£10,000 inc VAT)  
from [pcspecialist.co.uk/reviews](https://pcspecialist.co.uk/reviews)

**Z**ircon is a gemstone not to be confused with the synthetically produced cubic zirconia. Instead, it's a naturally occurring gold-hewed mineral that comes in a variety of shades. PCSpecialist clearly considers its high-end entry to be a bit of a gem and it's certainly packed with cutting-edge components.

Despite the return of the non-Pro AMD Ryzen Threadripper, PCSpecialist opted not to go with this variant for the Zircon Extreme. Instead, it uses the 32-core AMD Ryzen Threadripper Pro 7975X. This offers 64 threads and runs at the same frequencies as the non-Pro version – a base 4GHz with 5.3GHz boost. However, the Pro processor supports eight-channel memory and has 128 PCI Express 5 lanes, so can offer higher memory bandwidth while supporting many more high-speed peripherals than the vanilla Threadripper.

Strangely, however, although PCSpecialist has included a healthy total of 256GB DDR5 memory running at 4,800MHz, this is supplied as four 64GB DIMMs rather than eight 32GB ones. This means that you can't take advantage of the extra bandwidth from the eight-channel memory capability unless you add another four DIMMs. On the plus side, while we don't envisage 256GB feeling like too little during the lifetime of this system, the Asus Pro WS WRX90E Sage SE motherboard has four DIMM slots free for upgrade and seven PCI Express 5 x16 slots, although one of these only operates in x8 speed mode.

Despite the Threadripper Pro having a significantly higher price than the equivalent Threadripper, PCSpecialist has still managed to include AMD's flagship graphics acceleration. The Radeon Pro W7900 has 6,144 Stream processors and a huge 48GB of GDDR6 frame buffer with 864GB/sec of bandwidth.

PCSpecialist has taken a traditional approach to storage with the Zircon Extreme, providing one faster, smaller drive for the operating system and

apps allied with a larger, slower one for general data. The former is hardly small, however. It's a 4TB Samsung 990 Pro NVMe M.2 unit, although this is a PCI Express 4 drive, delivering 7,463MB/sec sustained reading and 6,985MB/sec sustained writing in CrystalDiskMark 8. The data drive is a 10TB Seagate IronWolf Pro 7,200rpm conventional hard drive, capable of 262MB/sec reading and 258MB/sec writing. This enterprise-grade disk comes with a three-year data recovery service and a 2.5 million-hour MTBF backed by a five-year warranty.

The chassis is also conventional – a Fractal Define 7 XL. This is the larger sibling of the case supplied by InterPro this month. This version includes eight 2.5/3.5in drive brackets and two 2.5in brackets, with up to 23 drive positions possible. PCSpecialist has equipped the chassis with a potent 1,000W Corsair RMx series PSU, so you can happily add power-hungry components to this system.

Unsurprisingly, with the same number of cores of the same generation as the Scan £10,000 system's AMD Ryzen Threadripper, the Threadripper Pro in the Zircon Extreme performs very similarly in CPU tests. The *PC Pro* media benchmarks score of 866 is just one point lower, with identical video-encoding and

**ABOVE** The Zircon Extreme is packed with cutting-edge components

**BELOW** The chassis includes eight 2.5/3.5in drive brackets and two 2.5in brackets



multitasking results of 816 and 1,096 respectively. Only the image-editing score drops behind at 274. The Cinebench 2024 multi-CPU rendering score of 3,493 is a tad ahead of the Scan, too, although the Blender Gooseberry frame took 165 seconds, around 10 seconds longer. We can't help thinking that all these results would have been higher had PCSpecialist taken advantage of the Threadripper Pro's eight-channel memory.

The flagship Radeon Pro W7900 certainly shows how much AMD has to offer graphics acceleration these days, though. The SPECviewperf 2020 scores of 291 in 3dsmax-07 and 1,057 in maya-06 make this the fastest system for 3D animation viewsets this month. CAD and engineering workloads are also impressive, with 210 in catia-06, 278 in creo-03, 772 in snx-04 and 598 in solidworks-07, although these aren't the fastest in every area. The GPU also delivers the second-best inferencing performance with Geekbench ML at 28,093 and a third best 17,255 in LuxMark 3.1 OpenCL.

Overall, this is a very competent system from PCSpecialist with great performance across the board, but spending extra on the Pro version of the Threadripper without providing eight memory DIMMs is a missed opportunity.





## SCAN 3XS GWP A1-TR64

A well-balanced high-end workstation with superb CPU power and real-time graphics capabilities

SCORE ★★★★★

PRICE £7,917 (£9,500 inc VAT)  
from scan.co.uk

**S**can is the second manufacturer this month to take advantage of the return of the non-Pro AMD Ryzen Threadripper CPU. However, Scan has opted for a lesser model than Armari, enabling more potent graphics acceleration and a different performance balance as a result.

Specifically, Scan chose the AMD Ryzen Threadripper 7970X. This is the 32-core variant, which offers 64 threads and a base clock of 4GHz with a 5.3GHz boost. Of course, with AMD processors that have Precision Boost Overdrive enabled, the actual frequency will depend dynamically on power and temperature. Otherwise, the specifications are the same as the Armari CPU, with quad-channel memory support and 48 PCI Express 5 lanes plus 24 PCI Express 4 lanes.

With a cheaper processor than Armari, Scan has spent some of its savings on providing double the memory. There are four 64GB GDDR5 DIMMs, enabling quad-channel bandwidth and running at 4,000MHz. These are ECC modules, too, for enhanced stability. The Asus PRO WS TRX50 Sage WiFi motherboard supports a maximum of 1TB, but you probably won't need any more memory in the lifetime of this system.

Another area where Scan has spent its CPU savings is in the graphics acceleration. We've seen 6000-series Nvidia RTX GPUs in the higher workstation price category before, but Scan has gone one rung down to the 5000 Ada Generation. This has a huge 12,800 CUDA cores and 32GB of ECC-backed GDDR6 frame buffer delivering 576GB/sec throughput.

Scan hasn't entirely pushed the boat out when it comes to storage, however, with only a single drive included. It's still relatively large and very fast, though. The 4TB Corsair MP700 NVMe M.2 unit operates at PCI Express 5 speeds, delivering 12,354MB/sec sustained reading and 11,758MB/sec sustained writing when we tested it in CrystalDiskMark.

If you need more, the good-looking Fractal North XL chassis offers two 2.5in drive mounts and two 2.5/3.5in mounts, so you can easily add more. The North XL's wooden slatted front bears a more than passing resemblance to a freestanding heating unit created by a leading Swedish interior designer. Scan has also included a 1,000W Corsair RMx1000 PSU, which should handle all the powerful components with aplomb.

With half the cores of Armari's high-end entry this month, the Scan system was never going to get close to it in CPU tests where this was the key aspect. The overall PC Pro media benchmarks score of 867 is still the second highest this month, with superb results of 281 in image editing, 816 in video encoding and 1,096 in multitasking. The Maxon Cinebench 2024 multi-CPU result of 3,459 falls marginally behind the PCSpecialist Zircon Extreme, coming third in the Labs. The Scan took 155 seconds to complete the Blender Gooseberry render, the second fastest.

While the Scan system can't compete with Armari's 64 cores, its more powerful GPU makes it one of the best this month for real-time viewport acceleration and

**ABOVE** The Scan GWP A1-TR64 is a classy, well-balanced system



**BELOW** The Fractal North XL chassis contains a 1,000W Corsair RMx1000 PSU



GPU-assisted computation. The Nvidia RTX 5000 Ada Generation provides very competitive SPECviewperf 2020 3D animation results of 255 in 3dsmax-07 and 814 in maya-06. CAD and engineering workloads are even better catered for, with 202 in catia-06, 222 in creo-03, an incredible 1,210 in snx-04 and 609 in solidworks-07. But the W7900 is significantly faster in 3D animation.

The GPU delivers an impressive 27,069 for inferencing with Geekbench ML and 20,282 with LuxMark 3.1 OpenCL. To underline the power of this GPU, when rendered on CUDA the Blender Gooseberry frame took only 75 seconds to output – the second fastest GPU result we've seen.

The Scan GWP A1-TR64 is a more balanced system than Armari's £10,000 offering. It's also about £500 cheaper. However, the Armari is not so behind on graphics acceleration as it is ahead on CPU tasks, and that gives it the win overall. Scan still earns five stars and a Recommended award for good reason: if your workflow is more skewed towards intensive real-time viewsets and GPU accelerated computation, it's a better choice. And it looks great, too.





# View from the Labs

Generative AI is making its way into workstations, and creatives should grasp the opportunities that the technology will bring

This month's Labs provided our first foray into testing workstation performance for AI inferencing. Right now, this is a tentative workload on local systems, with most generative AI being processed remotely via services such as ChatGPT, Google Gemini and DALL-E. But creatives who aren't already experimenting with using these tools in their work should be – in part out of concern that AI will make their jobs obsolete, but also for positive reasons. By getting on top of the technology, and incorporating it into your own work practices, you might just enhance your workflows and explore new creative areas.

Online image generation services such as DALL-E make heavy use of GPUs, and even more will have been employed to create their AI models in the first place. But those GPUs are all located in data centre servers, which users access through a cloud service. You can run the AI image generation platform Stable Diffusion locally, though; see [tinyurl.com/361diffusion](https://tinyurl.com/361diffusion).

I wouldn't be surprised to see installable desktop software provide this type of service in the near future, and we're already seeing signs of how this might work. Adobe Photoshop now has AI-powered generative fill



**James Morris is a former editor of PC Pro and an expert in the field of graphics workstations**

**“Creatives who aren't already experimenting with using AI tools in their work should be”**

built in, and the company's Firefly service produces complete AI-derived images. The downside is that these tools pull their content from Adobe's online servers and, while the costs may be hidden or soaked up by Adobe now, you'll pay in the end. After all, there's a cost incurred by developing generative AI models, and companies will want to recoup their investment.

Creating synthetic images from scratch is only part of how AI will infuse creative work. Image-editing tools performing tasks such as smart background removal or automated video editing based on content could call upon AI to improve their results. Adobe has integrated AI-based sound

enhancement into Premiere Pro, using technology it beta tested via an online podcasting tool. The results aren't always perfect, but it can produce incredible results

with one click in many cases, reducing background noise where traditional methods such as noise print subtraction are less effective. This can make audio usable that would otherwise have needed re-recording.

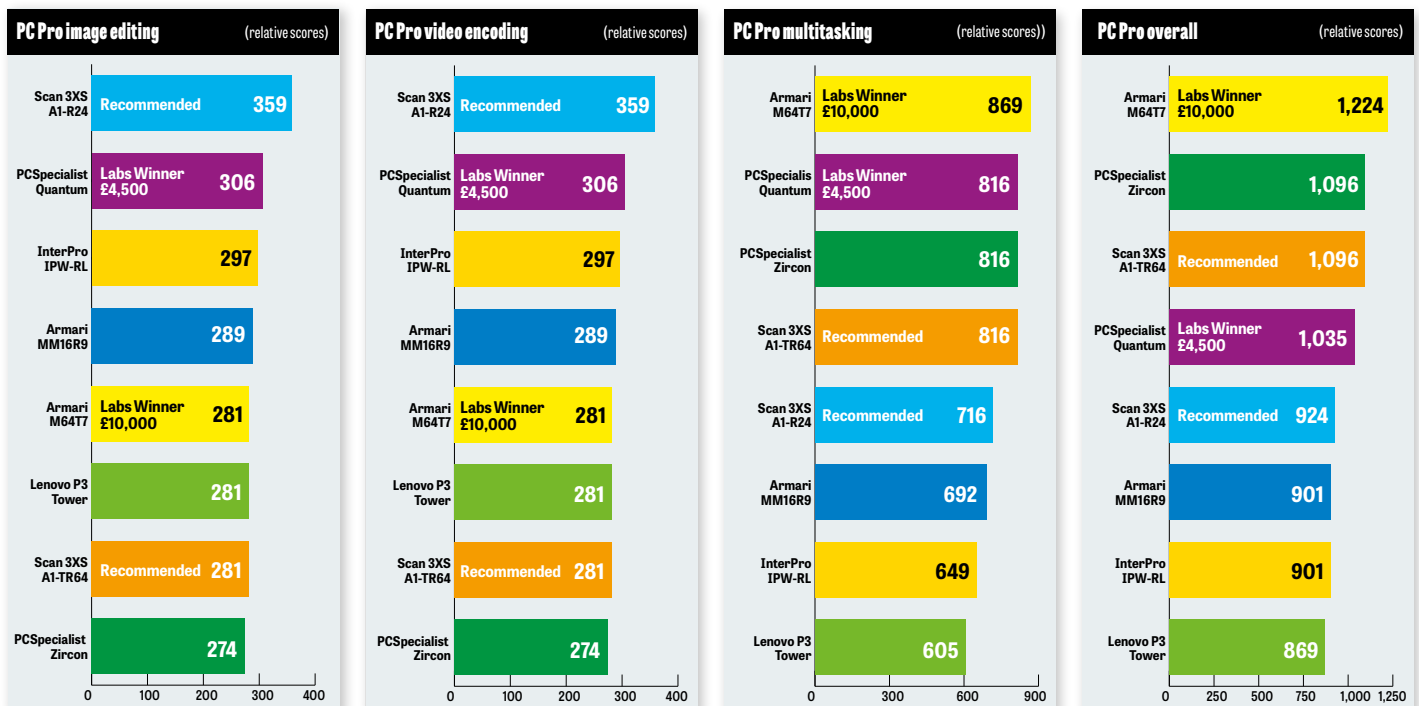
It's also possible that design software will respond intelligently to verbal commands. For example, an

engineer could rapidly develop a prototype by telling the software what they want using voice commands, and then improve the output with further spoken statements until the desired results are achieved. Online generative AI image tools already operate in this way via text prompts, continually drawing on their trained models to provide updated suggestions based on new input.

These functions are intensive and benefit greatly from GPU acceleration. This is why Nvidia's share price has shot through the roof; its H100 AI inferencing GPU costs around £30,000, and Nvidia still can't keep up with demand. The workstation GPUs in this month's Labs are nowhere near as powerful, but as our tests show they provide a significant boost when processing AI inferencing.

We're at the beginning of the journey for generative AI. Nobody knows where that journey will end. Some are predicting mass destruction of jobs, while others think that's scaremongering. For the creative industries, it will be essential to use the technology to enhance work rather than replace it. Having a workstation that can process AI quickly could be a key part of keeping your content creation capabilities current. ●

## Test results



# The Network

Practical buying and strategic advice for IT managers and decision makers

## Buyer's guide

# Remote support 2024

Whether you're new to remote support software or have already invested, you may be surprised by how much these latest products can help



As flexible working becomes the new normal, businesses of all sizes must adapt their IT support services to cope with the challenges they present. These working arrangements bring undeniable benefits in terms of productivity and efficiency, but in order for them to be effective, companies must find new ways to provide essential support regardless of where their staff are located.

It's impractical for technicians to personally visit users every time they have a hardware or software issue and, in many cases, they may also be working remotely. Telephone support is inefficient as it's often impossible to fix a problem without having access to the user's system.

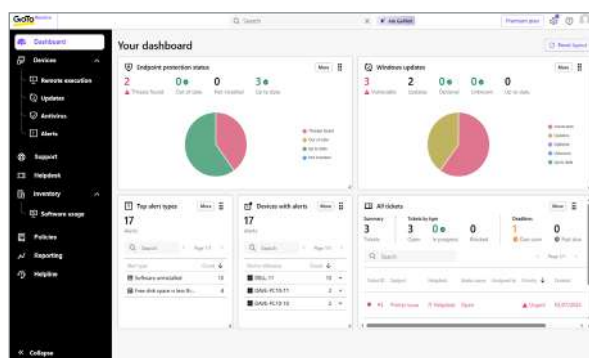
Remote support software is the answer as it puts technicians in front of the user's troublesome workstation without having to be physically present in the room. They can take control of remote systems from the comfort of their own desk to diagnose and fix problems with consummate ease.

The good news is that flexible working is driving a huge demand for remote support, resulting in a wide choice of affordable options ideally suited to small and medium businesses (SMBs). In this month's buyer's guide, we look at cloud-hosted and on-premises solutions from four of the big names – GoTo, ISL Online, NetSupport and Zoho – and help you choose the one that best fits your new working model.

### ■ Safety and security

Security must be a top priority when choosing a remote support solution.

**BELOW** GoTo Resolve includes endpoint protection in its support package



These products are designed to provide technicians with full remote access to a user's desktop, making them a dangerous tool in the hands of cybercriminals.

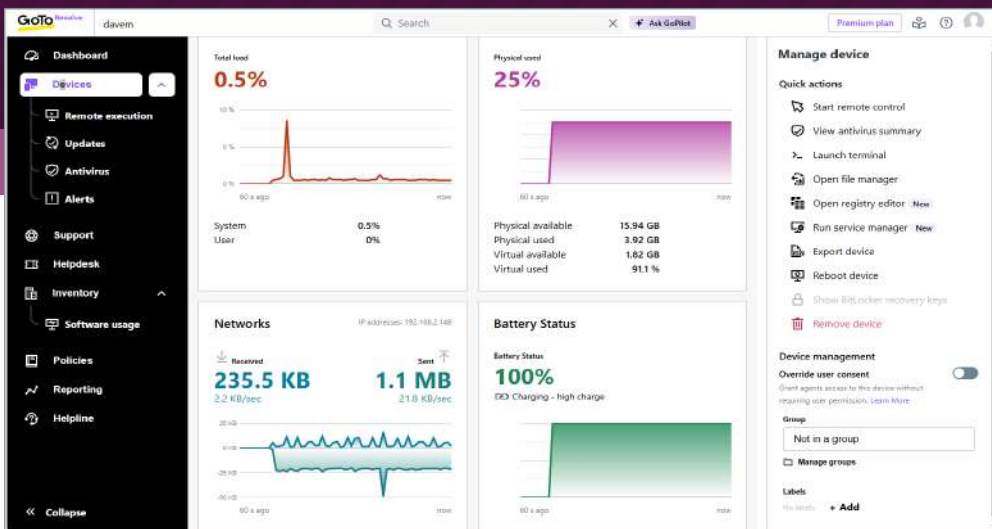
Indeed, scammers are well aware of this and frequently use trial versions of support software to send bogus support requests in an attempt to trick users into giving them full control. Fortunately, most vendors have wised up to this and either block on-demand access in trial versions or warn users that the invitation may not be a bona fide request.

You can mitigate this further by standardising on a single remote support product and ensuring all your staff know which one you're using. Educate your employees about remote access scams, too, so they know how to recognise and decline unsolicited invitations.

### ■ Agents of change

All remote support products require an agent to be loaded on client systems to allow technicians to access them. Ad hoc or on-demand support sessions require both sides





to agree to the connection request, after which a temporary agent is downloaded to the remote system.

Nothing is permanently installed and, once the session has finished, the agent is removed without trace. This method is the most secure as the technician's console generates a unique PIN that the user must enter and, on completion of the session, there's nothing for an intruder to use to gain illicit access.

All-hours access to unattended systems requires an agent to be loaded permanently. Running in the background, the agent stays connected to the remote support service, allowing technicians to access the system as and when required.

This is the least secure option so ensure unattended agents offer features such as password protection. Access to the technician's console also needs to be locked down, so look for solutions that offer multi-factor authentication. One product in this guide requires technicians to enter their personal signature code before they can initiate a support session.

### ■ On-premises or cloud-hosted?

Businesses that don't want to rely on a third-party provider will find an on-premises support solution the best option. These employ an on-site central management server, which provides complete control over data and access security.

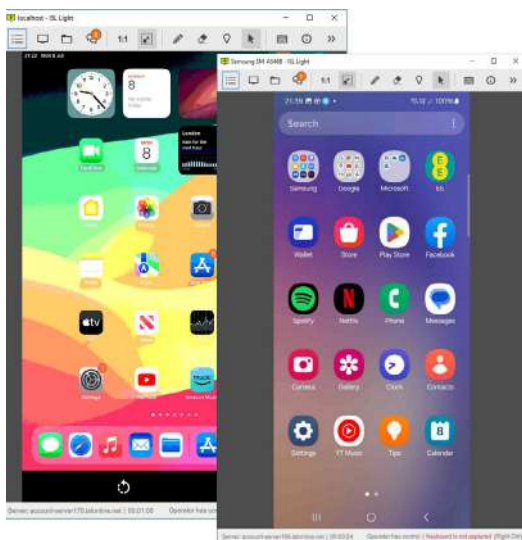
They generally use unattended agents, but these can only be deployed from the company's management server by authorised technicians. Remote offices and workers are supported, too, as the on-premises solution we test

includes a gateway component that extends secure, encrypted access over the internet.

Cloud-hosted remote support will appeal to businesses embracing flexible working as these products lend themselves well to supporting staff spending their working week between the main office and home. They're

**ABOVE** The GoTo Resolve agent offers a live view of hardware on the remote system

**LEFT** ISL Online client support includes iOS and Android mobiles



very simple to deploy as they don't require an on-premises host, and their subscription-based licensing makes it easy to control costs.

Technicians aren't tied to the office, either, as they can access the service from their personal web portal and run on-demand sessions from wherever they are located. All good cloud providers offer unattended agents as well, but make sure you check their licensing plans as some provide this service only as a chargeable option.

### ■ Tools of the trade

Support isn't just about remote control; all good solutions offer a treasure trove of tools that will help technicians swiftly diagnose and fix problems. These include file transfer, screen sharing, audio, video and chat services, note taking and remote Registry editors, plus facilities to view and control running services.

Session recording can create a video audit trail of support sessions that can be used for training purposes. Workstation inventory can be very useful as technicians can see what's installed on the user's computer prior to starting a support session.

Most support products focus primarily on Windows endpoints but, if you have a mix of devices, check what other platforms they support as

**"Access to the technician's console needs to be locked down, so look for solutions that offer multi-factor authentication"**

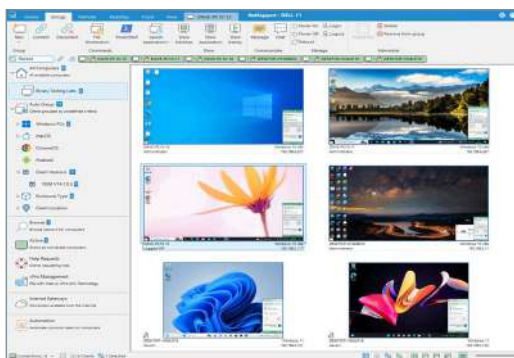
many offer agents for macOS, Linux and Android. You can't remotely control iOS devices due to the operating system's strict security model, but most products provide client

apps for iOS users to broadcast their screen contents to technicians.

Businesses supporting a large user base should consider service desk and ticketing systems so incoming user requests are queued and sent to the most appropriate technician. Live chat is another feature to look for, as technicians may be able to use this to solve a problem without having to initiate a session.

The right remote support solution will boost productivity, and the four products in this guide were chosen as they're available as free time-limited trials so you can try them out. They all offer a wealth of valuable features and tight security, so read on to see which one will help your business on its path to flexible working.

**LEFT** The on-premises NetSupport Manager offers an informative remote support console





## GoTo Resolve Standard

GoTo seamlessly teams up cloud-hosted remote support, zero-trust access security and endpoint malware protection

SCORE ★★★★★

**PRICE** One agent/25 devices, £44 exc VAT per month billed yearly from goto.com

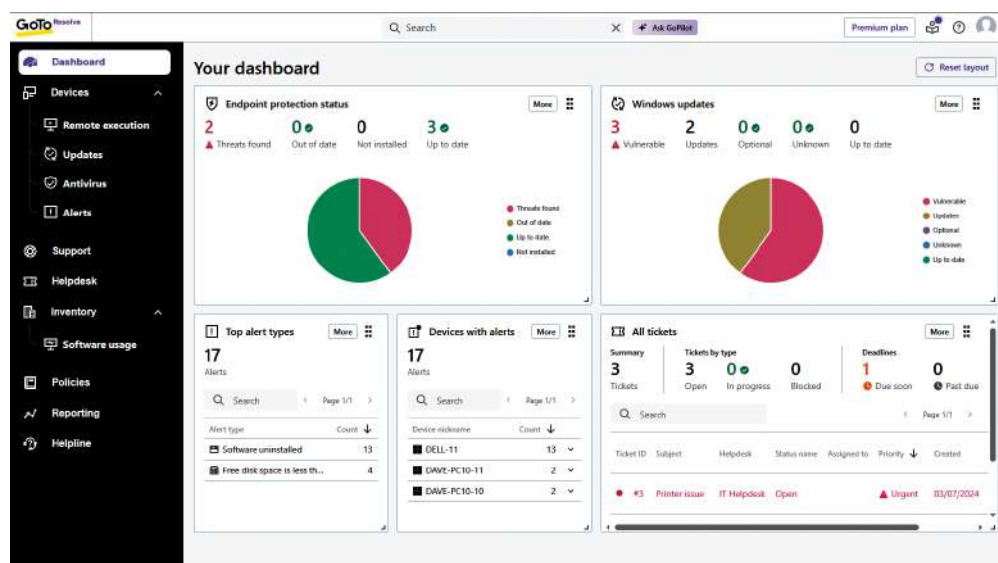
**G**oTo Resolve has a laser-sharp focus on remote support access security, and it now augments this with endpoint protection services. These include antivirus and patch management, while the Resolve “GoPilot” streamlines support sessions with AI-powered assistance.

This cloud-hosted service is available in four plans, with the Remote Access edition providing unattended support and starting at £18 for unlimited users and 25 devices. The Remote Support plan enables attended access for on-demand support and is priced per agent.

The Standard plan we review combines unattended and attended access, adds remote execution services and enables endpoint protection, GoPilot and custom script alerts. The Premium edition adds Windows and application update management.

The basic plans interact with existing anti-malware solutions such as Windows Defender and provide status and threat updates. The endpoint protection add-on has a yearly cost of £17 per device and uses the BitDefender engine for enhanced threat detection and self-healing scripts to clean up detected malware.

To access unattended systems technicians create a personal signature key of at least eight characters and, for added security, GoTo doesn’t store them in the cloud. You can set Resolve



to ask for this every time a technician accesses a sensitive task such as deploying the unattended agent, but if this becomes tedious you can set it to request it once a day or week.

Resolve’s unattended access differs from others as it loads a background service linked to the technician’s key. During deployment from the technician portal, you can download the Windows and macOS file or share a web link that is also used to retrieve the Android app.

Once authorised by the technician, each one appears in the portal’s Devices view and for our Windows 10/11 hosts, it confirmed the Firewall and Defender services were operational. The portal’s dashboard provides status charts for endpoint protection along with tables of the top alerts and an overview of all support tickets.

Selecting a device provides details of the CPU, memory, and OS and BIOS versions. The performance monitor tab displays real-time graphs of CPU, memory, network interface and disk utilisation. A menu puts all support tools at the technician’s fingertips, with options to run unattended remote control, terminal sessions, a file manager, Registry editor and more.

**ABOVE** Client support is good and Resolve provides plenty of remote support tools



**“AI comes into play when you use GoPilot as it can assist diagnosis with lists of suggestions based on your queries”**

**BELOW/LEFT A** dashboard shows the endpoint protection status

Unattended remote control presents the device’s screen in a central window, and you can have active sessions to multiple devices and swap between them on the sidebar. Each interface provides a ribbon menu for chat, file transfer, note taking, screen sharing or blanking and rebooting.

Starting an on-demand session generates a unique nine-digit access code along with options to copy the web link and send the invitation via email. End users are presented with personal details of the technician for authenticity and asked to download

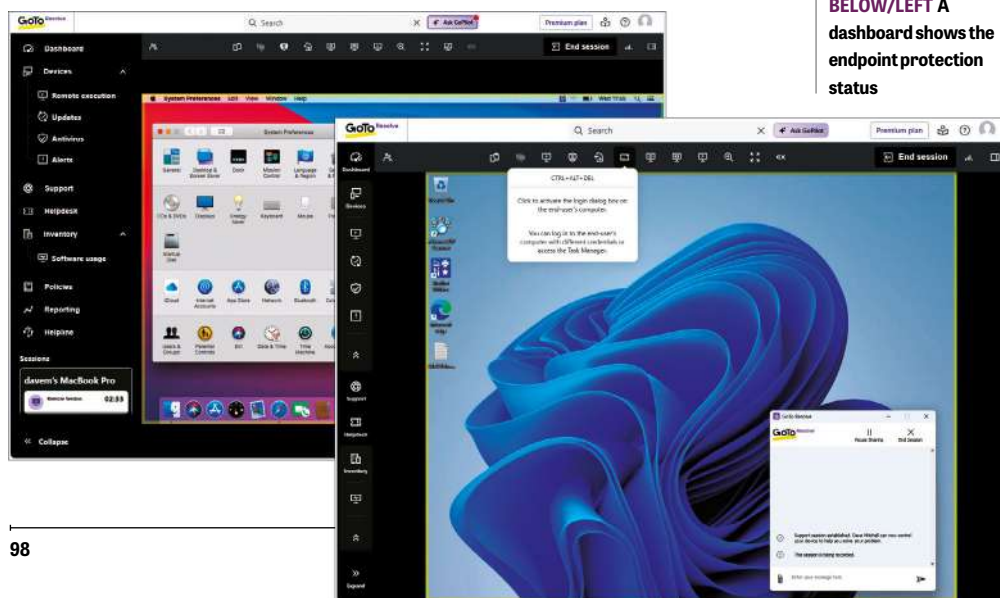
the Resolve runtime app, after which the session starts and the technician is presented with the same screen and toolbar as for unattended access.

AI comes into play when you use GoPilot as it can assist diagnosis with lists of suggestions based on your queries, help with session notes and provide guidance when creating remote execution scripts using PowerShell and JavaScript. Enable Helpline on your Resolve customer portal and GoPilot can walk users through troubleshooting steps without involving a technician.

GoTo Resolve Standard takes remote support to the next level, combining tough access security measures with endpoint protection services. Add-ons such as camera sharing plus Android and iOS mobile support cost extra, but it provides a wealth of valuable support tools and Resolve’s slick AI-based services can help accelerate problem resolution.

### REQUIREMENTS

**Technician:** Windows 10, macOS 11, Android 9, iOS 13 upwards. **Add-ons:** Endpoint protection, £16.80 per device • camera sharing, £276 per agent • mobile support, £180 per agent (billed yearly exc VAT)





## ISL Online Standard

ISL Online offers highly secure cloud-hosted remote support with a licensing plan for every occasion

SCORE ★★★★★

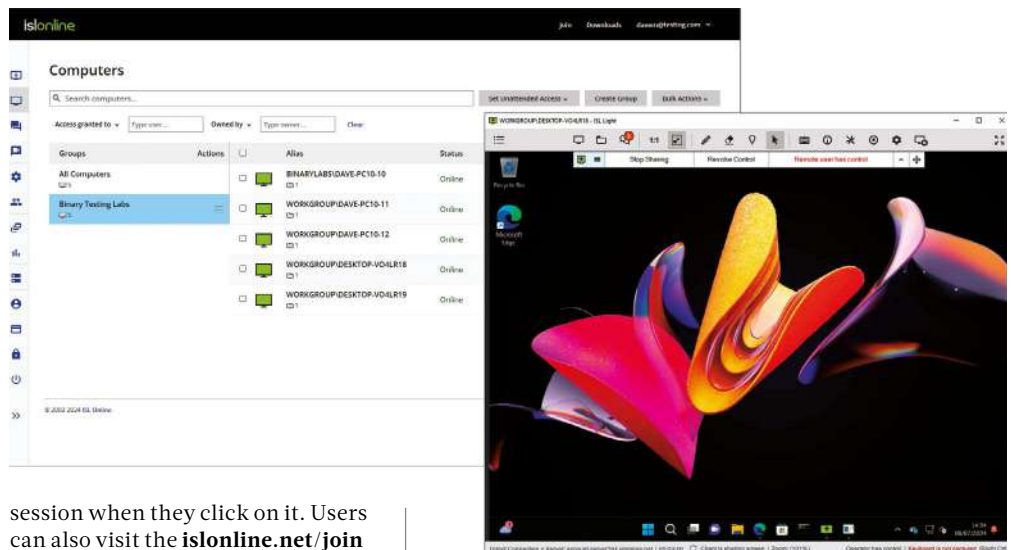
**PRICE** Standard Cloud/One user, £287 exc VAT per year from [islonline.com](http://islonline.com)

ISL Online probably has the most flexible licensing schemes of any remote support solution available. SMBs anticipating only occasional use can purchase a £75 pay-per-use contract for 500 minutes of unrestricted support sessions, while those with more ambitious plans can host it on-premises, opt for a privately managed cloud version or pick a Cloud licensing model.

The Standard Cloud plan we've reviewed here starts at £287 per year for one concurrent user, which allows one active session to be shared across all support staff. You can easily adjust your plan if you need more concurrent sessions and, unlike some competing cloud-hosted solutions, the price includes both on-demand and unattended remote support.

The technician's cloud portal has undergone a welcome design refresh, and starting an on-demand remote session runs the ISL Light app, which generates a unique eight-digit code. Technicians can install the app permanently on their computer, but if they're on the road then they can use the runtime version.

The app's Invite button offers options to directly email a web link to the client or send it using your own mail client, and this opens the



**ABOVE** ISL Online presents a tidy web console and plenty of support tools



**“General security is excellent, as ISL Online applies end-to-end AES 256-bit encryption to all sessions”**

session when they click on it. Users can also visit the [islonline.net/join](http://islonline.net/join) URL to enter the code, and in all cases, the ISL Light client runtime app is installed on their system and loads an upper control bar for granting or revoking remote control and stopping sharing.

The technician's window shows the client's screen and presents a toolbar across the top with quick access icons for a range of different tools. Technicians can share their screen with the client, request control, run file transfers, annotate the screen, enable screen recording, blank the client's monitor and pull up a handy display of system hardware details and utilisation.

The administrative mode in the Tools menu brings remote reboot into play, while the “restart and resume” mode restores access after the client machine has been rebooted. Clicking on the upper left hamburger icon loads the ISL Light app interface so they can pause the session, share it with another technician or transfer it to them.

Mobile support is excellent, with the free iOS and Android apps having a dual purpose. They can be used by technicians to access their cloud accounts and provide support on the go, or alternatively users can enter a key to join a support

session where technicians receive full remote control for Android devices or screen broadcasting for iOS mobiles and tablets.

Unattended access requires the AlwaysOn agent installed permanently on each computer, with Windows, macOS and Linux versions provided in the portal. Access security is good: agents must be password-protected during installation, or you can use the portal's custom deployment service to create an installation link with a global password only the technician knows.

General security is excellent, as ISL Online applies end-to-end AES 256-bit encryption to all sessions. Access to the cloud portal can also be protected with two-factor verification using an authenticator app, a code sent by email or a security key.

Other features include the ability to run web conferences from the portal, where it loads the free ISL Groop app for all invitees for online meetings and sharing slide presentations or your screen. Live chat services are included with the free ISL Pronto application, which requires an on-premises Windows, macOS or Linux host and embeds quick access links in your company website.

SMBs that want easily managed cloud-based remote support will find that ISL Online has an awful lot to offer. Platform support, features and access security are excellent, and its flexible licensing plans allow businesses to tailor costings precisely to their needs.

### REQUIREMENTS

Windows 7/Server 2008 upwards, Linux, macOS 10.6 upwards • **Mobile app:** iOS 11, Android 5 upwards



**BELOW/LEFT** Client support includes macOS, iOS and Android devices



# NetSupport Manager 14.1

In-house remote support at its best, with a superb range of technician features for a one-time fee

SCORE ★★★★★

**PRICE 1-500 systems, perpetual licence, £10 each exc VAT from [netsupportmanager.com](http://netsupportmanager.com)**

**S**MBs that want to keep all their remote support services on-premises need look no further than NetSupport Manager (NSM), which is one of the best solutions on the market. Cost control is another compelling argument since, unlike cloud-hosted services that incur regular monthly fees, NSM is priced on the number of systems you want to support and its perpetual licensing plans mean you pay only once. Now well into its third decade, NSM benefits from constant development with version 14.1 delivering new features and security enhancements.

NSM delivers a wealth of support tools, including remote control, view and screen sharing, file transfer, text or two-way audio chat and recording facilities, remote application launch and Registry-editing tools, plus a highly detailed hardware and software inventory.

Out of the box, NSM defaults to requiring a client's permission for a support session, and technicians now have the ability to blank the remote screen while viewing it. Value gets a boost, too, with NSM including a full copy of the latest NetSupport School classroom management and training

solution, which can be deployed alongside NSM using a custom setup.

Installation is swift. We loaded the NSM Control component on a Windows 11 host in around one minute and used its Deploy tool to scan our entire local network and push the client to all our Windows 10/11 client machines. NetSupport has malware activity covered during this phase, as it will prevent the client executable from running if its name has been changed.

Cloud-hosted solutions lend themselves well to supporting staff in remote offices, but NSM has this covered as well as its Gateway and Connectivity Server components are included in the price. Installed at a remote site, these lightweight services are highly secure: they enforce 256-bit AES session encryption, use a unique key that the client must possess in order to connect to the Gateway, and you can decide which technicians are allowed to access them.

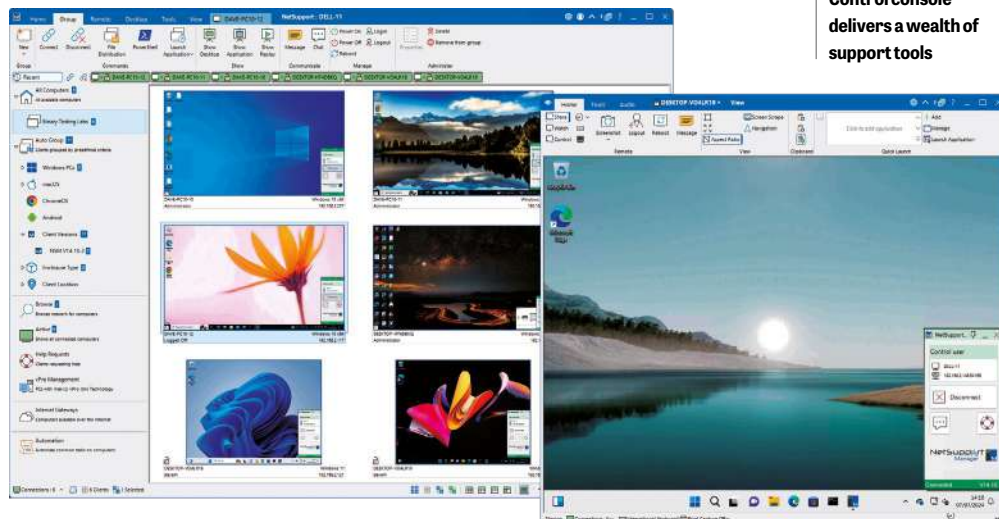
The Control console is easy to use, with its left tree menu placing clients in various categories and custom groups for swift access. Auto groups are a smart feature, with NSM dynamically sorting clients based on attributes such as their installed OS,

**ABOVE** The iOS Control app provides easy access to all clients



**"NSM's monitor mode displays scalable thumbnails of the clients' screens so you can watch user activity in real-time"**

**BELOW/LEFT** The Control console delivers a wealth of support tools



NSM client version, enclosure type (including virtualised PCs) and geographical location.

NSM's monitor mode is a feature you won't find in most cloud-hosted products. This displays scalable thumbnails of the clients' screens so you can watch user activity in real-time. Users needn't worry about being spied on as when a technician connects, their local NSM app alerts them and they can disconnect at any time.

A remote control session is started by double-clicking on a client icon and this presents a new window with a wealth of support tools in its upper

menu. Along with choosing to control, share or passively view their screen, technicians can launch local apps, have text and audio chats, take screen captures, share clipboards, reboot

the client, show their Control screen to single or multiple clients and make training recordings and replay them to clients.

Hardware and software inventory includes all apps and hot fixes, with the Task Manager tool providing a list of processes and services that can be remotely stopped, started or paused. NSM's file distribution tool is another great time saver as it allows technicians to select local files and send them to multiple clients in one go.

NetSupport Manager sets the standard for on-premises hosted support for both local and remote workers. It delivers a remarkable range of support features and its one-time cost per seat will appeal to businesses concerned about ongoing subscription fees.

## REQUIREMENTS

**Control:** Windows 7/Server 2012, macOS 10.15 upwards, Linux • **Mobile Control app:** iOS 12.3 and Android 5 upwards



## Zoho Assist Enterprise

Good-value cloud-hosted support with a wealth of technician tools and a keen focus on access security

SCORE ★★★★★

PRICE £19 exc VAT billed yearly per technician/month from [zoho.com/assist](https://zoho.com/assist)

**Z**oho Assist is a cloud-hosted remote support service that will appeal to companies of all sizes. Small businesses may find the free version sufficient as it supports one technician, unlimited support sessions and five unattended desktops, but if you want more Zoho offers a range of affordable plans that can be upgraded or downgraded as required.

We reviewed the Enterprise plan, which enables everything Assist has to offer and costs £19 per technician each month when billed yearly. Bear in mind that the plan enables on-demand remote support sessions only; if you also require unattended access, you'll need a separate licence, with the Professional plan starting at £12 per month for 25 computers.

The good news is that if you go for on-demand and unattended plans, both services are presented in the same technician web portal for easy access. It's consistent across all plans, with four upper tabs for running on-demand sessions, accessing computers with the unattended app, using the augmented reality feature for chat, audio and live-streamed video support, and viewing session reports.

The latest version of Assist sees plenty of new features, with access security at the top of the list. A

credential manager securely stores login details for multiple computers, IP-based restrictions can be applied to control account access, and the Geo Insights dynamic map shows frequency and density of support sessions by region.

Unattended agent deployment options are outstanding: Assist can now use its own distributor agent, email links, Group Policy Object and Microsoft Azure, SCCM or InTune. Agents are available for Windows, macOS, Linux, Android and Raspberry Pi and are preconfigured for your account. Once installed, the systems appear in the portal account of the technician that generated the deployment for quick access.

On-demand support sessions can be run immediately or scheduled for later. Either way, the portal generates a unique nine-digit code and provides options to copy the web link and send email or SMS invitations.

Once the user has entered these details in their browser or clicked on the link in the email, it downloads the Assist runtime app and asks them to permit the connection. The web page sensibly warns against accepting unsolicited invitations, and you can add that extra touch of authenticity with custom email templates that include details such as technician and company names.

**ABOVE** The Assist technician portal provides easy access to systems



**"A diagnostics menu allows technicians to run a command prompt and access all key Windows management services"**

**BELOW/LEFT** Geo Insights provides a global view of support sessions

The technician's remote control screen provides a pop-out sidebar offering options for sharing their screen, locking the user's input devices and inviting other technicians to take a look. A tools menu provides power and reboot controls plus remote script execution, while a diagnostics menu allows technicians to run a command prompt and access all key Windows management services such as the Registry editor and Device Manager.

File transfer can be run from here but can also be selected directly from the portal's device view, where it loads a runtime app on the technician's computer that

displays local and remote drives. Unattended access is a swift one-click operation, and technicians receive the same screen as for on-demand sessions,

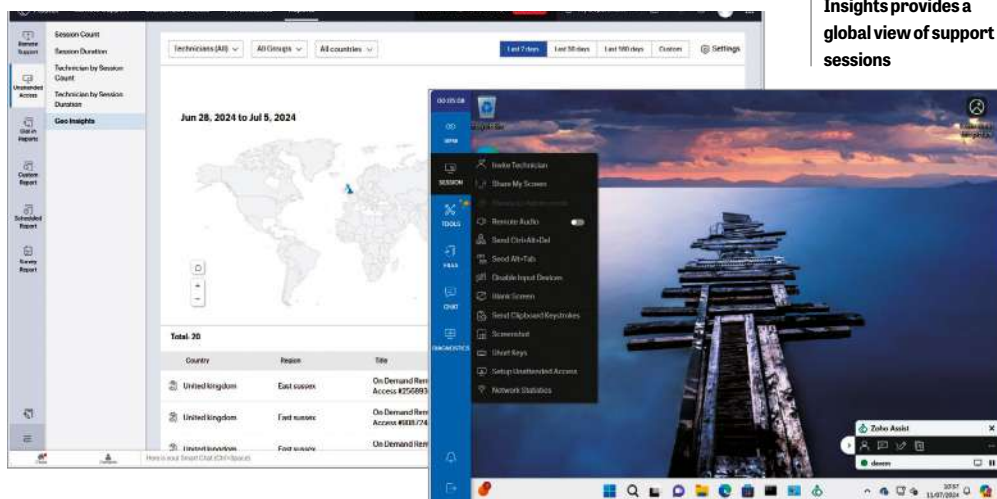
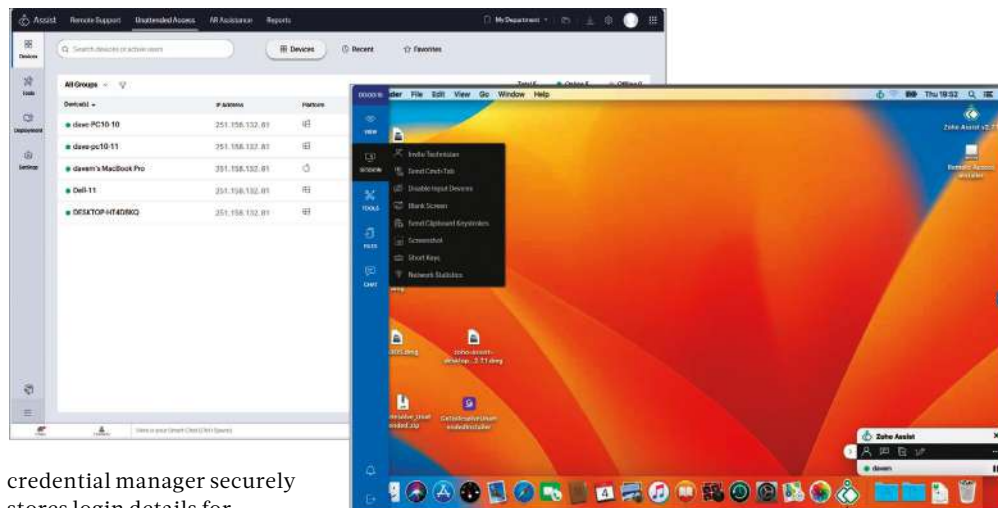
with the Enterprise plan allowing up to six to be open simultaneously.

The new dynamic grouping feature will appeal to technicians responsible for large numbers of systems as this organises them based on their OS, domain membership, device name or manufacturer. Other new features include service queue chats prior to support sessions and improved customer and technician surveys with post-session redirection to custom forms.

The Zoho Assist package delivers uncomplicated cloud-hosted remote support that's very easy to manage. Unattended access is licensed separately, but the Enterprise plan is still an affordable option and delivers a wealth of new features with tight access security.

### REQUIREMENTS

**Technician/client:** Windows 7/Server 2012, Chrome OS 16, macOS 10.9, iOS 11, Android 5 upwards, Linux (all versions)





## Netgear PR60X Pro

A feature-rich, business-class router that's 10GbE-ready, easy to manage and priced right for SMBs

SCORE ★★★★★

PRICE £547 ex VAT  
from broadbandbuyer.com

Netgear has traditionally offered an outstanding range of network switches and wireless access point (APs) for small to medium-sized businesses (SMBs), but routers have always been conspicuous by their absence. Not any more: the PR60X Pro fills this void in Netgear's product portfolio by delivering a 10GbE-ready solution offering plenty of routing capabilities, dual WAN failover, support for up to 30 site-to-site IPsec VPNs and an integral firewall.

Powered by a 2.2GHz quad-core ARM A73 CPU partnered by 2GB of DDR4 memory, this slimline 1U rack unit offers a 10GbE copper port configurable for LAN or WAN duties, a 2.5GbE WAN port and three 2.5GbE LAN ports, all of which are the multi-gigabit variety. You get a 10GbE SFP+ uplink port for long-distance connections over fibre, and a neat touch is its status LEDs are presented front and back so you can rack-mount it in either orientation.

Deployment scenarios are manifold since the PR60X Pro can be used to head up a small office network and provide secure internet access to all connected devices. Larger businesses with regional offices can place a router

in each location and link them together over site-to-site VPNs.

The PR60X supports a standalone mode plus Insight cloud management and includes a one-year Insight subscription in the price. The pricier PR460X is exactly the same, but this model is aimed exclusively at integrators, has a four-year Insight subscription and a more generous five-year hardware warranty.

We started testing in standalone mode and followed the router's quick-start wizard, which sensibly requested an admin password change and upgraded its firmware to the latest version. The console is nicely designed and presents an informative dashboard, with a topology graphic showing connected devices along with status views of the system, each network port and all VPNs.

The fifth port defaults to LAN duties but you can change this to a WAN port and team it up with the other one for failover duties. You can decide which are primary and secondary connections and apply a policy so that if one fails, the second takes over; the router doesn't support load balancing.

The firewall is enabled out of the box and provides basic SPI (stateful packet inspection) services, along with port scan and denial of service protection. It can be customised with rules that specify connection directions,

**ABOVE** The slimline PR60X offers a 10GbE copper port for LAN or WAN duties



**"The PR60X Pro provides a powerful set of routing, VPN and WAN failover features. It's an affordable option for SMBs"**

**BELOW/LEFT** It can be managed locally or remotely via Netgear's Insight web portal

source and destination addresses, protocols and allow or deny actions.

The router comes with a set of predefined IPsec VPN profiles for services such as Microsoft Azure and Amazon Web Services, to which you can add custom profiles. Along with site-to-site VPNs, the router supports client-to-site VPNs and the third-party OpenVPN service.

Quality of service (QoS) configuration for the WAN ports is simplified by the router's Smart Queue Management (SQM) feature. Run an internet speed test from the web console and it will automatically configure itself with the discovered upload and download speeds to ensure that latency and congestion are kept to a minimum.

Adding the PR60X to our cloud account was simple enough, as we used the Insight iOS app on an iPad to scan its QR code and assign it to a site. It duly appeared as a new device on the portal's router section, and we noted that you can still manage it from

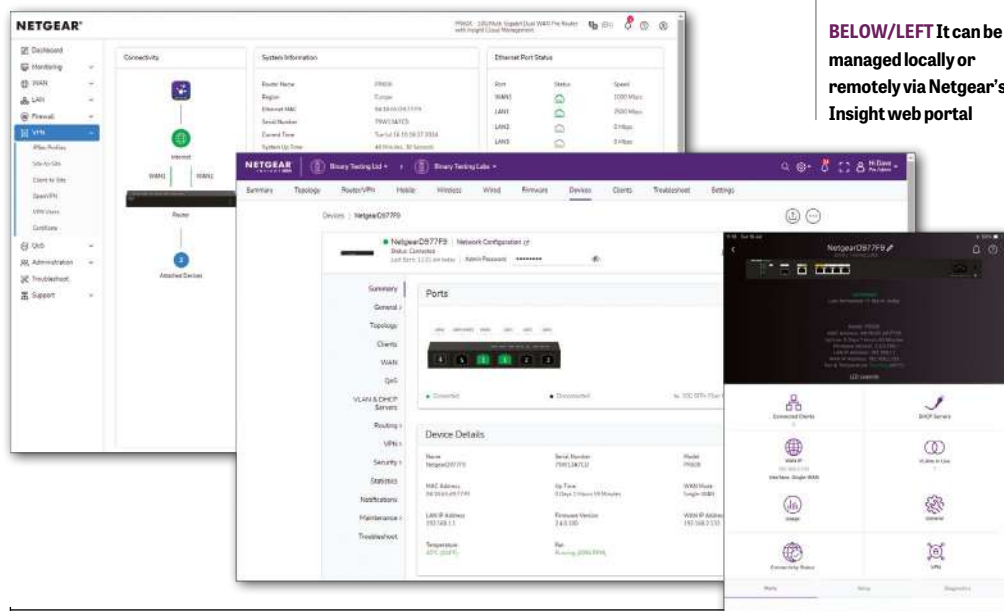
the local interface.

The Insight portal provides access to all the same settings, so you can remotely configure the WAN ports, firewall traffic rules, port triggering and forwarding, IPsec VPNs and the like. A topology map shows how your devices are linked to each other, you can view connected clients and keep an eye on hardware stats such as operating temperatures and cooling fan speeds.

The PR60X Pro neatly fills a gap in Netgear's networking armour and provides a powerful set of routing, VPN and WAN failover features. It's an affordable option for SMBs, can be easily managed locally or in the cloud, and its 10GbE WAN port is ready and waiting for ultra-fast broadband. **DAVE MITCHELL**

### SPECIFICATIONS

1U rack chassis • 2.2GHz quad-core ARM A73 CPU • 2GB DDR4 RAM • 4GB eMMC • 10GbE WAN/LAN • 2.5GbE WAN, 3 x 2.5GbE LAN (all multi-gig) • 1 x 10GbE SFP+ LAN • internal PSU • rack-mount brackets • 440 x 100 x 43mm (WDH) • 1.5kg • web browser/Insight management • 3yr NBD hardware warranty





## Zyxel Nebula FWA505

This versatile 5G wireless router will appeal to SMBs that want freedom from wired networks

SCORE ★★★★★

PRICE £245 ex VAT  
from broadbandbuyer.com

**Z**yxel's Nebula NFWA505 is designed to deliver wire-free internet access. This compact desktop mobile router teams up 5G with Wi-Fi 6 services and targets a wide audience including small businesses, SOHOs, mobile workers, pop-up stores and those that can't get decent fixed-line broadband speeds.

The FWA505 replaces Zyxel's older NR5101 (see issue 338, p103), but is more competitively priced and sees a design refresh, with all ports arranged vertically at the rear. The status LEDs have been moved from the base to the front of the unit and it also sports a pair of smaller TS-9 connectors at the back for optional external aerials.

Two gigabit ports are provided, with the first offering LAN or automatic WAN failover services and the second used for connecting other devices to its network. Its Wi-Fi 6 AP is AX1800-rated and delivers speeds of up to 1,200Mbps/sec on its 5GHz radio and 573Mbps/sec on the 2.4GHz one.

As the model name indicates, the FWA505 can be cloud-managed

from Zyxel's Nebula Control Center (NCC), and the price includes a one-year Pro Pack licence, with subsequent years costing around £28. You'll need to familiarise yourself with its local web console, though, as unlike Zyxel's fully compliant Nebula wireless APs and security routers, the FWA505 doesn't broadcast cloud SSIDs and can only be configured from its own interface.

It's easy enough to deploy as the web interface loads a wizard to get you started. Zyxel supplied our review unit with a Vodafone 5G SIM installed in the micro-SIM slot in the base, which provided instant cellular internet access.

The web console opens with a dashboard showing the status of local and internet connections, cellular status and details of wireless networks. A

default SSID is provided for both radios and, although

it uses the weaker WPA2 encryption, the encryption key is randomly generated and you can easily swap to the more secure WPA3.

Up to four SSIDs are supported, with three secure guest wireless networks

already configured for you.

These can be modified as required with the Guest WiFi tickbox enabling L2 isolation so users on these SSIDs only get internet access.

Network security is present and correct, with the router's firewall offering three protection levels that can be quickly selected using



**ABOVE** Status lights on the front of the unit show you what's what

**LEFT** Two gigabit ports are provided on the rear of the router

**"It's well designed, easy to use, delivers respectable wireless performance and can be remotely managed from the cloud portal"**

**BELOW/LEFT** Nebula provides remote access to its local web console from the cloud

a slider bar. Custom firewall rules comprising protocols, port numbers and ACL (access control list) entries can be created, while parental control profiles limit internet access to specific days and times and enforce URL and keyword blocking.

The gigabit WAN port can be used for internet access and teamed up with the mobile SIM for failover. We tested this by pulling the cable out and the router automatically swapped over to its 5G SIM in one minute.

The FWA505 also delivers respectable wireless speeds. Copies of a 25GB test file between a Windows 11 Pro workstation equipped with a TP-Link Archer TBE550E Wi-Fi 7 adapter and a server

on the gigabit LAN averaged 107MB/sec at close range, dropping to 85MB/sec with the router ten metres away in an adjoining room.

Adding the FWA505 to our NCC account was simple as we scanned its QR code from an iPad running the Nebula iOS app. A mobile router status widget is added to the site dashboard and selecting it provides more hardware details, a location map and remote firmware upgrade

services, plus views of WAN and cellular status and information about wired and wireless clients.

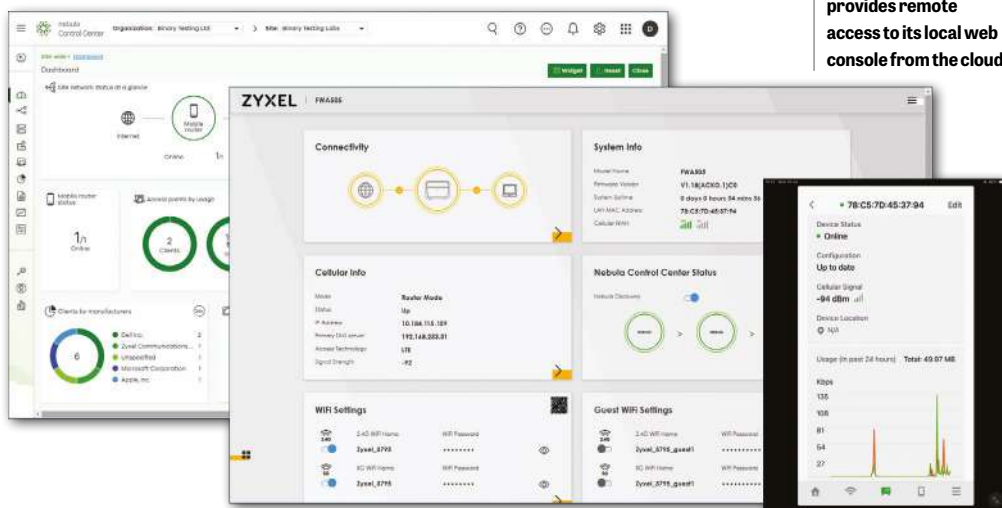
The NCC Pro Pack licence increases traffic monitoring from 24 hours to 30 days but,

more importantly, enables a remote configurator. Select this from the router's Live Tools section and it will establish a secure HTTPS remote web console session so you can access all its settings.

Small businesses and remote workers that want to go completely wireless will find the Zyxel Nebula FWA505 an affordable solution. It's well designed, easy to use, delivers respectable wireless performance and can be remotely managed from Zyxel's Nebula cloud portal. **DAVE MITCHELL**

### SPECIFICATIONS

- AX1800 dual-band 2.4GHz/5GHz 802.11ax
- 2x2 MU-MIMO
- 4G/5G micro SIM slot
- 2x gigabit (LAN/WAN, LAN)
- USB-A 2
- 2x TS9 external antenna ports
- 103x103x222mm (WDH)
- 584g
- external PSU
- 2yr RTB warranty





# Hyperpersonalisation: The perfect service for every customer

The first rule of business is to give the customer what they want.  
Steve Cassidy explores the technology that lets you do just that



**M**ove over mail-merge: simple personalisation techniques such as pasting people's names into emails are old hat. Hyperpersonalisation is about learning as much as you can about a person's behaviour, interests, activities and so on, and dynamically tailoring your digital offering to give them the perfect experience they didn't even know they were looking for.

Now, since you're reading *PC Pro*, there's a pretty good chance that you're coming to this topic from an IT perspective. And that's fine, because hyperpersonalisation is absolutely an IT function, and even brings AI into the equation as we'll see. However, hyperpersonalisation is primarily to do with marketing and customer relations, and implementing it isn't solely an IT project. As is often the case with these 21st-century trends, this isn't a single product you can deploy, or a pre-packaged service you can buy in.

## ■ What does HP mean?

Put simply, hyperpersonalisation – or HP for short, not to be confused with the long-standing brand of laptops and printers – is the idea of learning everything you can about a customer, and using that information to present them with their own personal version of your business offering. Your marketing messages, website home page and ordering process can all be customised to match up to their needs and interests, so they get the best possible experience – and you get the best chance of making a sale and keeping their loyal custom.

Although the term hyperpersonalisation is relatively new, the idea hasn't come out of nowhere. It has its roots in customer relationship management, and specifically the idea of bringing together all your interactions with a customer in one place. In other words, HP stands on the shoulders of an already pretty sizeable

**“As is often the case with these 21st-century trends, this isn't a single product you can deploy”**

**BELOW Data from search engines can help build your customer profiles**



industry: back in 2013, Salesforce was able to build itself a whole new skyscraper in downtown San Francisco on the back of its CRM revenue. And since

that project began more than a decade ago, innovations in the area of client tracking have continued, bringing capabilities to a point that might have seemed like science fiction when the foundations for Salesforce Tower were originally laid.

Because HP is more than just an updated version of CRM. From a data-collecting perspective, the big difference is that HP looks beyond the factual record of customer interactions, to bring in information from a much wider range of resources. Some of these might be your own data sources – your sales ledgers and website logs – but they can also include public profiles, search engines and statistical data. Most people exposed to



CRM packages will be familiar with the fundamental (and legally important) distinction between internal and public information, but with hyperpersonalisation that division somewhat fades away.

That's not to say that direct interactions don't remain valuable. For the most effective HP you want to be talking to your customers as much as possible. Business consultant Deloitte offers a nine-point list of ways to increase contact, and to be honest I personally shudder at some of the suggestions – web-shop chatbots? Nein danke.

However, the list does provide some useful pointers for learning more about your potential clients, and I reckon you could easily triple its length, by including tools for linking back ends to back ends, and the essential of any analysis product – a management and reporting tool that lets you dream up questions to put into the combination of rules and services that comprise your customer relations database.

The other key difference between CRM and HP lies in how you use the data. Where traditional CRM focuses on direct contact, HP works without human interaction: the customer shouldn't need to talk to anyone, as the experience laid out before them will already answer all their questions and address their needs.

This isn't to say that HP fully replaces human contact. All information collected and analysed for HP purposes can also help sales and customer service operatives give a better service. One HP-inspired CRM system I've seen automatically trawls news sites looking for mentions of the customer's company, helping the live agent to strike an appropriate tone and propose the right product or solution.

### ■ How does a business implement HP?

You can start an HP project from scratch at any time: a customer with no HP profile is just the same as a new customer. You can begin collecting useful information on day one, and every time an enrolled client interacts with your business – perhaps in ways as simple and innocent as hitting pages on your website – you can gradually learn more about them.

You don't need to be a major enterprise to get the benefits. Small businesses tend to have more tightly focused activities, which means it shouldn't be too hard to transition from – for example – sending out templated newsletters to a more persuasive series of long-term interactions with the customer crowd.



**ABOVE** Personal digital assistants could be a data goldmine, albeit a problematic one

Nor are big powerful servers required. Many of the important questions for HP are ones such as “what will my customers value as a promotional gift?”, which can be perfectly well addressed by humans. Indeed, I'd caution against trying to compute the answers to such

open-ended questions: modern AI chatbots may give you confident-sounding answers, but they don't know your customer base, and their constructed recommendations can't substitute for your own experience in the business.

**“Modern AI chatbots may give you confident-sounding answers, but they don't know your customer base”**

At the same time, there's certainly a role for AI when it comes to crunching the data. I'm not just talking about auto-summarising here: there's a vast quantity of demographic data and behavioural

data freely available online that has – for good legal and commercial reasons – been anonymised. While this means you can't specifically identify that a particular named individual owns two dogs and drives a Renault, you can still feed the big-picture statistics into an AI and see what light they shine on your customer database.

Today's engines can pull off some quite remarkable tricks of inference and correlation, to make predictions about your customers' lifestyles, budgets, attitudes and more. This sort of modelling can actually be more useful than getting your customers to talk directly to an AI chatbot – because website visitors generally want to get a job done and log off, rather than exchanging personal chit-chat with a machine.

Overall, the biggest challenge in embracing HP might be the necessary shift in mindset, as focusing on what your customers actually want is a completely different perspective to the traditional marketing angle of trying to induce them to buy what you're offering. And you should be able to see what HP's doing for you using the same metrics you're (hopefully) already monitoring; it's not very meaningful or necessary to try to track HP activity in isolation, as success will be reflected in your sales figures. The only area where you might want separate reports from just the HP system is with no-buy decisions. You don't then want to know about the successes; the failures are where your growth can be found.

### ■ The audio conundrum

While poring through the available databases of anonymous user data, you might notice that little or none of it appears to build on audio interactions, even though the

## My CRM confession

Some decades ago I had a personal involvement in the sort of profiling project that would eventually feed into hyperpersonalisation. My version wasn't purely commercial, however; it was designed to track down a fraudster. The client was trying to deal with a situation where – thanks to the borderless markets of the EU – an individual might pop up in Paris one week and Stockholm the next, each time trying to sell Madrid airport (yes, really) to a different branch of the same bank. Our challenge was to piece together whatever we could about them.

Our database was pretty crude as such things go – fast, pervasive internet and large online repositories of personal data weren't things we could rely on in 1997. But it was fully distributed, surviving a terrorist attack in Manchester without a byte of data being lost, and well able to distribute sudden updates and data model changes without drama or risks to that data. It's not a field I'd want to go back to, I must say: the cognitive effort required to extract “all the bad guys of Serbian extraction worth over \$10 million” by way of our very primitive reports writer was frankly an agony and a punishment.

millions of things people say every day to Alexa – or to Siri, or to the Google Assistant – ought to be a goldmine of slice-of-life insights. In fact, until recently there's been very little attempt to hyperpersonalise the digital assistants themselves, beyond basic measures of learning your home address and your favourite radio stations.

This isn't for want of processing power. Alexa's own AI kicks in right at the start of the data capture process, with machine-learning algorithms applied to the audio stream to cut out background noise and other interference. Some further degree of interpretation is then applied to make sense of the registered command, and Amazon has confirmed that it's soon going to start using a more powerful AI framework on the back end to make the whole interaction smarter. But making the captured sentences and symbols available for external use seems to be a no-no.

The whole psychology of audio as a selling medium is a difficult world. As with web chats, users don't want to have extended interactions with voice assistants, and they don't like being processed or addressed by a non-human, especially not in their own homes. They may be receptive if the tech can really improve their lives or save them money, but this isn't likely to work for small-scale, everyday interactions; a new laptop or car purchase might be a more suitable deployment for a hyperpersonalised shopping cart.

So while there are almost certainly opportunities being missed here, we may have to wait for voice assistant providers to work out a way of realising them that doesn't fall foul of privacy concerns – or doesn't come across as just downright creepy.

## ■ Email isn't going anywhere

The culture of marketing emails is deeply embedded in many processes, and indeed entire careers. Whether it should be so in 2024 – whether it should ever have been so – is debatable. There are surely better ways to engage a customer than dropping unsolicited digital leaflets into their inbox that start with "Do not reply to this email". As well as being intrusive and non-interactive, email has a trust issue. Most people are aware that messages can be fraudulent or contain dangerous links, so it's hardly surprising if emails tend to be ignored and distrusted.

The more personal an email is, however, the better a reception it's likely to get – so it's a perfect candidate for hyperpersonalisation.



With a bit of analytics and some simple code – of the sort that most web servers already use – you could assemble custom emails that anticipate each recipient's most pressing issues, and offer one-click solutions with unique discounts to make them feel special. Moreover, rather than running a standard weekly mailshot, you could time your messages to reach each customer at the point when they're most receptive, at whatever frequency they find most agreeable. Who knows, they might even come to look forward to your emails.

In reality, this degree of email personalisation is rare, if it's practised at all, but it's the way smart businesses are moving. In my case, I receive about six emails a year

**ABOVE** Emails that are hyperpersonal are more likely to be received well

**"The more personal an email is, the better a reception it's likely to get – so it's a perfect candidate for hyperpersonalisation"**

telling me that a new consignment of rack-mount servers – average cost between £3,000 and £10,000 – will soon be available to order. I signed up very consciously for this kind of advance notice, because I am always likely to have a project in progress, or in prospect. And as part of my

subscription, I've already told the mailer some very specific things about my interests – projects per year, average spend and so on. The sender uses this information to ensure that when the emails arrive they are relevant. They also include a link for me to log straight into their website and explore different specifications with zero friction – and by tracking what I'm looking at, the sender has an opportunity to learn more about my evolving needs and interests, which could help the emails become ever more pertinent.

While the CRM guys might not like it, one of my favourite things about these interactions is the complete absence of human interaction. I don't want to be reading out part numbers and technical details to a sales guy, and I certainly don't want him pushing me to compromise on my needs and buy whichever system will get him the most commission. The very specificity of the email also gives me some confidence that the sender is legitimate, because the odds of a random spammer correctly guessing the sort of server I'd be interested in are tiny – although you can never dismiss the risk of a cleverly-targeted spear-phishing attack that turns personalisation against you. ●

## What we know about you

Whisper it, but we here at *PC Pro* know quite a lot about our readers. We know why you read the magazine, and we know how it factors into your purchasing decisions. We're also very aware of – and very grateful for – how long our subscribers stick around. We're not quite at the point of hyperpersonalising the content of the magazine for each individual reader, but the data helps us make decisions that will, we hope, keep our readers satisfied.

If you've read the main feature, however, you might not be surprised to learn that we don't use powerful AI systems to derive this information. It might be more fun if we did – along with a fleet of interactive bots for you all to talk to – but none of that is needed. We get by with our reader surveys, feedback from our industry partners and good old sales and revenue graphs. This isn't intended as a lament, nor indeed a boast, but just an example: consider what you can achieve with good old customer research and regular personalisation before you invest in a large-scale HP project.





# Distributed cloud

Don't put all your virtual eggs in one hosting basket:  
Steve Cassidy explores how to disaster-proof your business

## Isn't this a bit redundant? Surely cloud is by definition distributed?

Actually, it's not. The marketing might make you imagine that cloud deployments always include remote backup, failover, regional scalability, software updates and so forth. In reality, these things are very much in the realm of chargeable extras, or features you need to manage for yourself. In the case of distributed cloud, we're talking about a powerful set of standards for business continuity that should be compatible with your cloud package, but which are certainly not baked into it.

## So does it basically mean spreading our VMs across data centres?

A distributed cloud will indeed run across multiple geographical locations, using fast long-haul links to provide a functionally locationless global resource. More than that, it can (and should) also extend across different cloud providers, and even different hypervisor platforms. When it comes to business continuity you're in the strongest position if your deployment is capable of genuine cross-barrier migration, and is fully agnostic about on-demand routing and performance management.

## Are you saying I shouldn't entrust my VMs to a single provider?

Ideally, no. Even a big and respectable cloud host could be knocked offline when a natural disaster strikes, or when an undersea cable gets snipped, with recovery times potentially measured in days or weeks. If your provider ends up going bust, your VMs may never come back online. These scenarios are rare, but you need to plan for them. Don't assume that when the time comes you'll be able to simply copy your VMs from one cloud platform to a completely different one and carry on trucking.

## Isn't that the point of VM templates, though? So you can hop from one host to another?

It's true, things aren't as bad as they might be: in the early days of cloud engineering, some standard file formats were created that can help you push VMs around in a hybrid or multi-vendor cloud environment. But in 2024 we want and expect live migrations, instant failover, shortest-path routing... in short, a service with no delays, glitches or interruptions. Rolling out a VM template when your main service goes down won't cut it.

## So should we be running live VMs all the time, scattered about on different supplier platforms?

You can, if that's the scale of the service you need. However, the cloud is meant to be elastic, with servers spinning up according to demand, rather than continuously running just in case. The real goal of distributed cloud is a common VM configuration, with shrink/grow capabilities and wide-area failover, that will run identically on any available host. This then gives you the flexibility to dynamically decide where on the internet your next server instance should be located (a lot like the way content delivery networks operate).

## Should all businesses be investing in distributed cloud, or just the biggest ones?

Often these clever technologies are too expensive and complex for SMBs, but in this case smaller organisations will find it easier to distribute their server-side roles, simply because they don't have as many. Big enterprises are cursed with large, complex server arrays and legacy software tools that they dare not throw out, which may not adapt well to a big distributed cloud deployment. Of course, that's all the more reason why they need to be resilient: everyone ought to be at least exploring distributed cloud, if only so they can figure out precisely what it is that's stopping them from taking full advantage. ●

## What distributed cloud can't do

Distributed cloud can protect you from a wide range of risks, but it's not a magical cure for all digital ills. In recent weeks, many managers will have been searching for measures that might have protected them from the global CrowdStrike meltdown in July – but the truth is, a distributed cloud arrangement probably wouldn't have helped. That's because the distributed model relies on many VMs all running the same software in tight synchrony, so if a core component goes bad in one instance, it *ought* to go bad right across the deployment.

This in fact points to a subtle challenge of distributed cloud: while running multiple virtual servers in multiple places can lend you resilience, it also creates opportunities for problems to spread far and wide. The damage from CrowdStrike might have been reduced if someone had had the insight and the reflexes to leap in and prevent that part of the VM build from being propagated to other hosts, but that would really require you to be on a permanent war footing. Then again, that's not a bad mentality to have, if you can sustain it.



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# Real world computing

Expert advice from our panel of professionals

**JON HONEYBALL**

## “It’s time to put on your seatbelt because it’s about to get a little rough and tumble”

**Discover the full story behind the CrowdStrike update that took so much of the world’s infrastructure down**

**W**hat a mess. Everything that could have gone wrong actually did go wrong. And the response from the manufacturer leaves many questions unanswered.

I’m not, of course, referring to the disappointing chocolate digestive I’ve just eaten, but to the CrowdStrike calamity. The one that managed to take down whole chunks of the internet services platform on a global scale.

As was widely reported, Windows computers received an update to their CrowdStrike Falcon installation, and then blue-screen crashed. Rebooting the computer didn’t help. Recovery has usually involved booting the computer into Safe Mode, deleting some files and rebooting, and thus has required hands-on access (unless you had some sort of remote management out-of-bounds access as often found on rack-mounted servers).

To understand what happened, we need to look under the Windows hood. Like most modern operating systems, the system is split into two: the kernel and user space. The kernel is the core guts of the OS, and only trusted and digitally signed components should be allowed there. User space is the realm of applications, where almost anything can be run. Hopefully this is all digitally signed and clean, but the OS can take steps to ensure that an app doesn’t do bad things. If it does, and the OS notices, it can crash the app without taking down the whole system.

Things are different in the kernel. Everything there is meant to be solid and robust, and thus doesn’t need this sort of protective handholding. If something goes wrong in the kernel,

it’s best to just stop the computer. Taking a theoretical example: if something has gone wrong in the disk driver stack, continuing to operate might allow for wild and wrong writing of data to disk. It’s better to blue-screen stop the machine, and gather all of the necessary debugging information so Nominated Grownups armed with debugging tools can peer into the smoking wreckage and work out what went wrong.

So what did go wrong? Well, let’s look at the structure. CrowdStrike has a kernel driver that bolts itself into core of the operating system. It allows it, among other things, to scan network traffic and look out for bad things happening. This approach is typical for an antivirus or security analysis tool. It needs to have access to all of the network traffic to be able to see what’s happening. The same method usually applies for the disk storage stack as well, so all reads and writes can be monitored.

There’s obviously a lot more complication than this simplistic view. For example, it’s often the case that an antivirus/security package will install its own root certificate into the certificate store on the computer. By doing that it can then decrypt any HTTPS or TLS traffic, to peer inside. And this is necessary for examining traffic that’s now mostly travelling over encrypted channels.

Now I have no problem with kernel drivers. The operating system core is built with these things. The driver has to go through rigorous testing and then be digitally signed by Microsoft. This is a process exactly as you would expect. The problem arises when a driver such as the CrowdStrike item must respond to rapidly changing threats. It has to be updated, often multiple times each day, with new information as threats emerge.



**Jon is the MD of an IT consultancy that specialises in testing and deploying kit**  
[@jonhoneyball](#)

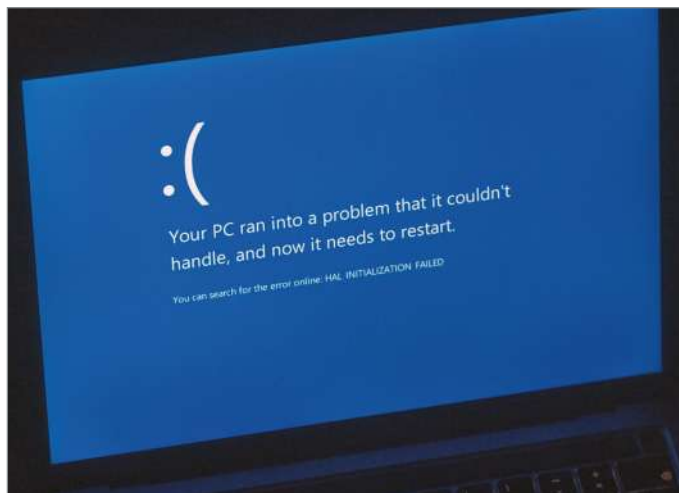
**“Everything was fine, up to the point when CrowdStrike sent out a file full of zeros”**

**BELOW** The dreaded blue screen appeared all over the world back in July

So a security company such as CrowdStrike, and just about every AV company out there, updates its list of nasties. In the case of CrowdStrike, these files are binary blobs of instructions, effectively code in itself. The driver loads the blob and processes its instructions.

Now it’s time to put on your seatbelt because it’s about to get a little rough and tumble. These definition files are read by a kernel driver during the boot sequence, and then subsequently through the operation of the computer. They’re effectively code that instructs and extends the capabilities of the core kernel driver.

There’s no code review for them, outside of what CrowdStrike was doing. Everything was just fine, right up to the point when CrowdStrike sent out a definition file which was, it seems, simply full of zeros. The kernel driver took this file, and then threw its toys out of the pram, trying to reference memory addresses that were invalid. The kernel panicked, and halted the machine with a blue screen of death.







**Jon Honeyball**

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Lawyer Olivia offers legal advice for the tech industry – p116



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**Steve Cassidy**

The wider vision on cloud and infrastructure – p122

At this point, you would probably just shout “reboot the machine and let Windows sort it out”. This would typically work because Windows has a system in place to guard against exactly this; a kernel driver that, for whatever reason, has gone AWOL. On the next boot, Windows can simply leave out that driver from the boot sequence, and the system then proceeds to boot normally.

However, this might not be a good solution for a security product that’s trying to protect the machine. Malware might have corrupted things, and bringing up the OS without the protection of the driver might allow for worse things to occur. Well, that’s what an AV company would tell you, of course, which is why CrowdStrike has a special marker on the kernel driver which tells Windows to load the driver irrespective of other issues.

This has therefore put huge levels of trust onto the third-party driver not to crash, because there’s then no way for Windows to sort out the mess.

## Boot on the other foot

This is exactly what happened with CrowdStrike. The driver was marked as “must boot”, Windows booted and loaded the driver, the driver read the configuration file, and then immediately crashed. And no amount of rebooting would fix this.

The first and most obvious question to ask is this: how did this badly mangled definition file get sent out by CrowdStrike in the first place? How on earth did it get past testing within CrowdStrike, because surely it would have crashed its test machines in exactly the same way that it did for everyone else a few hours later?

Now I’m not going to suggest that CrowdStrike was doing no testing, because that would be bad and wrong, even though it fits the sequence of events. You might think that its testing was wholly inadequate. Indeed, reading the CrowdStrike page detailing the issue, it is worth carefully checking what changes it’s going to make (see [tinyurl.com/361crowd](https://tinyurl.com/361crowd)): “Improve Rapid Response Content testing by using testing types such as: local developer testing, content update and rollback testing, stress testing, fuzzing and fault injection, stability testing, content interface testing.

“Add additional validation checks to the content validator for Rapid Response Content. A new check is in process to guard against this type of problematic content from being deployed in the future. Enhance existing error handling in the content interpreter.”

Which to me reads as “let’s do some serious testing, chaps”. It goes on:

“Rapid Response Content deployment: implement a staggered deployment strategy for Rapid Response Content in which updates are gradually deployed to larger portions of the sensor base, starting with a canary deployment.

“Improve monitoring for both sensor and system performance, collecting feedback during Rapid Response Content deployment to guide a phased rollout.

“Provide customers with greater control over the delivery of Rapid Response Content updates by allowing granular selection of when and where these updates are deployed.

“Provide content update details via release notes, which customers can subscribe to.”

Which to me reads as “let’s not send these files out to everyone in one go, and maybe get the users to specify whether they want to be on the immediate list, or a slightly delayed deployment, depending on their own determination of their risk profile”.



**ABOVE** CrowdStrike is deployed on a huge number of systems

**“How did this badly mangled definition file get sent out by CrowdStrike in the first place?”**

**BELOW** The impact of the outage was felt on critical infrastructure



You might ask why these things were not in place. This, as they say, is an exercise for the reader.

Next, let’s just step back and consider why CrowdStrike had such a big impact – taking down airlines and banking systems and touching on a huge range of infrastructure.

For this we have to consider that corporate-level IT security is a very different beast to the sort of AV protection you have on your laptop. I don’t mean what it does is different, but why it’s there.

You choose to install a third-party AV product if you decide that Windows Defender isn’t good enough. You’d probably be wrong in that decision as Defender coupled to a decent smattering of browser add-in filters is probably enough, assuming you have an adequate and tested data recovery process in place, too.

At enterprise level, your choice may not be voluntary: the use of these tools is often contractually mandated. Either by suppliers that your company is working with, which could include government agencies or other large organisations. Or mandated by your corporate insurers, especially when it comes to cybersecurity insurance.

I’ve been told of companies that have been given an extremely short list of vendors that are acceptable, and told to implement it – or there’s no contract. Or no insurance.

And the name that keeps cropping up on this list is CrowdStrike. That’s





why there is so much of it out there, on servers, both locally and in the cloud, and on corporate desktops. That's why big infrastructure systems went down, when the Windows systems got their CrowdStrike update and then blue-screened.

You might question the wisdom of a policy that mandates the installation of a product such as CrowdStrike whereby untrusted and clearly untested code is allowed to be run by a kernel driver on your Windows servers and desktops. You might want to consider going back to those suppliers and insurers and point out that the risks are considerable, and have just been demonstrated in a very public way.

You might also question why servers went down when they really should, and probably were, hosted in virtual machine environments. And why couldn't they be rolled back to a moment in time before the update occurred, and thus rebooted and brought back on stream? Or how exposed might you be if your estate of desktop computers keels over, especially if you're a live TV station and your newsroom can't work?

It might also be instructive to look at some history here. Back in the 2000s, Microsoft proposed that the then-new Windows 64-bit version should have a considerably hardened kernel. The move from 32-bit to 64-bit was an ideal opportunity to ratchet up the protection of the kernel, and it proposed allowing third-party companies, including AV companies, to use an API method to access all of

the information they wanted. This would allow the kernel to remain robust, and for the AV monitoring to occur in user space.

The AV companies pushed back hard, with (it is claimed) some vendors threatening court action, and complaints to the EU. Microsoft backed down and agreed to ensure an even playing field for third-party AV vendors, thus allowing them ongoing full access to the kernel.

I was somewhat saddened to read Microsoft complaining that this was responsible for the CrowdStrike outage, because, in its eyes, Microsoft should never have been forced into this position by the EU.

I can see both sides of this argument, and can certainly see why AV companies didn't want an API method, because it would have allowed you to install multiple AV products onto your computer in a safe fashion, and hence compare the efficacy of each one. And comparison is a difficult topic when everyone claims that their protection is just the best, despite no-one having financial liability for their failures beyond a refund of your subscription cost.

But one thing is clear. I hope this is a turning point for the industry. Too often, our badly designed and even worse implemented services can come crashing down around us. Talking of crashes, CrowdStrike's share price fell from around \$340 to roughly \$260 at the time of writing. But it's somewhat galling

**ABOVE** The outage caused airport chaos all over the globe

**"Too often, our badly designed and even worse implemented services come crashing down"**

**BELOW** QuadLock's tough cases are ideal for bikers – but aren't MagSafe compatible, despite the claims

to see that it's still massively up from around \$140 a year ago. Maybe these companies are just too big to fail.

If it was my IT, I would be carefully considering the choices made, and also ensuring that systems are really as robust as they are claimed to be. For those readers with a very long memory, maybe it's time for me to dust off my chainsaw.

## MagSafe or Not?

I'm always on the quest for the ideal case for my iPhone 15 Max Pro. When in the car, I have wireless CarPlay to a decent-sized screen in the central console, and also connectivity to my watch. So I can keep in touch with all important items with appropriate voice control. And keep an eye on my blood sugar level with a widget on the screen of my Watch Pro, which displays data from the Dexcom G7 continuous glucose meter.

When out on a motorbike, I prefer to drop the phone into a pannier and hook it up to a big USB battery pack. That way I can use it for navigation, phone calls and so forth, all through voice control.

GPS drains the battery of a phone at a rapid rate, so the big external battery pack is a must-have upgrade. I've recently upgraded from the Beeline Moto to the new version 2. This new version is an absolute delight. Way better than v1, which in itself was a wonder. It's a small screen that connects to your phone via Bluetooth. You run the Beeline app on your phone, and sort out the routing for your journey. As you ride along the phone updates the app using GPS, and you get concise and highly focused information – how soon to the next junction, which exit to take from the





roundabout, that kind of thing. The new version has a much bigger, colour screen and can show useful information such as junctions on the current road. And the speed limit, taken from the mapping tool on the phone.

It's a somewhat different creature to a full-blown Garmin product, but in many ways it's better when motorbike riding, where your concentration must be on the road and not looking at some pretty Ordnance Survey-esque maps. I noted with amusement that the Beeline 1 was the factory-fitted GPS option for Morgan motorcars, which seemed very apt.

However, it might sometimes be useful to have the phone in front of you mounted on the handlebars, and plugged into bike DC power. For this, the big player is QuadLock, which makes tough cases for a variety of phones. It also offers charging capabilities in the mountings, along with an anti-vibration mounting that can be essential for motorbike operation. I was particularly taken with the Mag case ([tinyurl.com/361magcase](http://tinyurl.com/361magcase)) for the iPhone 15 Pro Max, so I ordered one.

You'll be intrigued to note that the company only talks about "Mag" and not "MagSafe". You might be fooled, as I was, into assuming that it was actually MagSafe. So imagine my surprise to discover that it wouldn't work with the office Apple MagSafe charger cable. To be sure, I ordered a second case, and tried a second MagSafe cable. But there was no joy.

So I reached out to QuadLock in Australia. It replied saying: "In regards to charging performance, Apple's latest generation of iPhones have changed the minimum distance the charging coils will connect from, meaning we cannot guarantee that your MagSafe charger will work in conjunction with our Mag cases."

It has a Mag charger unit that I can use when the phone is next to my bed at night, so that problem is solved. And its car mount works very well in my Audi. But I had a nagging doubt, so I checked the box that the Mag case came in. And there at the top of the rear of the box are the words "Apple MagSafe Compatible Case".

I think that counts as an oops. But probably not as big an oops as the CrowdStrike outage.

@jon@honeyball.com

LEE GRANT

## "The chances of goosing a PC while performing a simple upgrade should be almost zero. Almost"

**As one man wrestles with a flashing Kraken, we relearn how to keep things local and ask if self-disassembling PCs are the future**

If you read my column in issue 360 then please accept my congratulations on making a wise reading choice for the second successive month. I should warn that what you're about to read isn't a reprint.

You may recall that I'd received an email enquiring about retrofitting the mighty Kraken Elite RGB cooler ([tinyurl.com/361kraken](http://tinyurl.com/361kraken)) into a machine and, thanks to my warning about potential leaks, the enquiry went cold. Well, the influential magic of *PC Pro* works in mysterious ways, and mere moments after the last issue hit the newsstands, I received an email confirming that the machine was being brought in to have a "Krak El 360" fitted.

The machine is a custom-built desktop sporting LEDs with the potential to fatally dazzle anyone who approaches without adequate sunglasses. This machine has a mixture of RGB and ARGB lights, controlled by various mechanisms which needed unpicking to get the El 360 into place. This upgrade is about adding extra bling to the machine rather than making any improvement



Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years  
X @userfriendlypc

**"I powered the machine, shielded my eyes and smiled as it whirled into life"**

**BELOW** Re-plaiting the rats' nest of cables tried my patience

to its thermal management, as this cooler's "killer feature" is a 640 x 640 pixel screen on the CPU block that can play animated GIFs.

The owner and I discussed the process and they requested, while I had the bonnet up, that I install a 4TB M.2 SSD into the machine as additional storage. Sure, why not?

You'll be relieved to learn that I'm not going to subject you to a play-by-play account of the Krak El 360's installation debacle. It took two hours and 37 minutes to get the old stuff out and re-plait the ridiculous amount of cabling to make it resemble a Christmas Tree on LSD. The whole front panel is a blend of mirrors and LEDs to create an infinity reflection illusion, with yet more LED strips on the side. At the top and rear were rainbow strobing fans that were driven by different control boxes to generate "spinning" and "flashing" voltage and controls. The Krak El 360 has its own RGB controller (so that's a total of three, if you're counting), which required two SATA power hook-ups to spark it into life along with a front-USB header to manifest the magic-lantern memes.

Once everything was re-tied and

tucked away, I powered the machine, shielded my eyes and smiled as the lights, LCD screen, fans and pump whirled into life. You may think that years of experience would bestow calmness and tranquillity during moments such as these. After all, I treat my customers' machines with a gentle hand, so the chances of goosing a PC while performing a simple upgrade should be almost zero. Almost. Instead of booting into Windows, the machine dropped straight into the BIOS.





## RTFM!

The usual explanation for this behaviour is that the Windows boot records have gone AWOL, so I diligently re-checked the wiring. All present and correct. During the cooler swap, I'd de-cabled and pulled the GPU to access to the motherboard's M.2 drive bay, which was hidden from view beneath a large metal heatshield. I'd installed the 4TB SSD into the third M.2 slot because the first two were already occupied with other M.2 SSDs. This machine wasn't short of storage, but like the lighting system, it was a hotchpotch of drives. Although the machine had 20TB spread over three PCI-E Gen 4 M.2 drives, the OS was firing off a 512GB SATA SSD. I'd previously advised the owner that cloning the SATA SSD to a much faster M.2 drive would be a sensible thing to do, but they were reluctant. Still, *nie mój cyrk, nie moje małpy*.

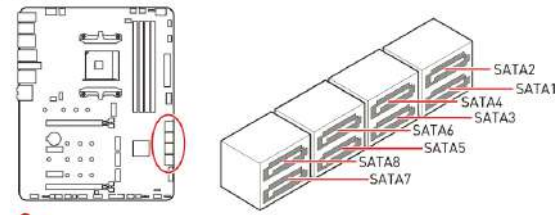
To satisfy my mind that I hadn't accidentally misaligned the M.2 drive while fitting the monster heatshield, I de-rigged the GPU wiring and support bracket (it was a stupidly large GPU which blocked access to SATA port 5), pulled the card and lifted the shield. It all looked hunky dory. For the second time on one job, I put everything back together, switched on and it went back to the BIOS. It was only when I checked the boot order that I noticed it was missing the SATA SSD, but at least all three M.2 drives were present.

Have you spotted my mistake? If so, award yourself a point because it took me a moment to realise I'd blundered. This time, I didn't have to take a screwdriver to the machine, but glance inside the motherboard manual, page 24 to be precise, where it states: "SATA5-8 will be unavailable when installing PCI-E SSD in the M2\_3 slot." This type of chipset limitation is very typical and can often trip up the inexperienced (and experienced) system tweaker. If you're currently poring over motherboard specs for a PC refresh, then don't get too dazzled by the vast array of slots and connectors as you'll probably discover that not all will be available. This is particularly relevant if you're trying to shoe-horn legacy devices into a new system, so take a dive into the documentation to be sure.

The solution to the non-booting machine was to shift the SATA data cable from port 5 to port 2, which

### SATA1-8: SATA 6Gb/s Connectors

These connectors are SATA 6Gb/s interface ports. Each connector can connect to one SATA device.



#### Important

- Please do not fold the SATA cable at a 90-degree angle. Data loss may result during transmission otherwise.
- SATA cables have identical plugs on either sides of the cable. However, it is recommended that the flat connector be connected to the motherboard for space saving purposes.
- SATA5-6 will be unavailable when installing SATA SSD in the M2\_3 slot; SATA5-8 will be unavailable when installing PCIe SSD in the M2\_3 slot.

required – for the third time – me to de-rig the GPU wiring and support bracket (it was a stupidly large GPU which blocked access to SATA port 5), pull the card, shift the cable then put everything together again. I turned it on, watched Windows load and then headed for the kettle. Those animated GIFs had better be hilarious!

## Doctor, I'm experiencing stiffness in my legacy

We're just over 12 months away from the end of Windows 10 support, and it's interesting to see its effects on our customers. The majority are tech-ambivalent and utterly unaware of W11's hardware restrictions and have purchased something new and shiny. Those that are more technically and/or environmentally aware realise that ditching working hardware is a kick in the pocket and the planet. Potentially more worrying for the PC industry are those – and there's a lot of them – who will abandon PCs after Windows 10 because they now realise that a decent tablet fulfils their needs. An increasingly common task I'm asked to perform is recovering photos from a goosed PC so they can be stored in iCloud/Google Photos.

**ABOVE** Not all slots on a motherboard will be available, as I found when I read the manual

**"After a few days of glueing and clamping, the laptop was back in one piece"**

**BELOW** Despite the progression of digital technology, laptop hinges remain a mechanical affair



Another user group concerned about the demise of Windows 10 are those running legacy software. To my left is a 2010 laptop described by its owner as "a bit slow". Given its age, you won't be surprised that the ailing hard drive failed a SMART test and demonstrated little in the way of integrity. Please feel free to add your own punchline about an MP of your choice here.

The laptop's owner is desperate to keep this machine running to use software for which they no longer have installation media and was discontinued over a decade ago. Several solutions are circulating, but I'm only mentioning it to highlight that the "just upgrade" business model is complicated for users chained to platforms by old software.

A month ago, I had my hands on a different laptop that uses legacy software to run an agricultural business. The soon-to-be retiring owner needed a short-term fix until they too were sunsetted. The fault was a simple hinge break, which we've discussed many times in *PC Pro*. The plastic screw mounting points on the lid had shattered, allowing the hinges to roam into the wild. Despite the progression of digital technology, laptop hinges remain a mechanical affair that would get an approving raised eyebrow from Isambard Kingdom Brunel, and the ones inside this laptop were incredibly stiff.

Using a bolt-shifter, I loosened the tension on the hinge-spring, which reduced the amount of torque required to open and close the lid. Actually, I deliberately over-slackened the spring, so the lid moved with so much ease that normal repair rules would decree that it was too

loose. This was to reduce the pressure on the re-glued fixings, which was the preferred repair option as a replacement rear panel was unavailable. After a few days of glueing and clamping, the laptop was back in one piece with a near frictionless lid action. Hopefully it will be sufficient to see the owner and machine into retirement.

## Local issues

Over the past few years, Microsoft has increased the benefits of using an online sign-in on Windows. For users who have gone all in



with Office and OneDrive backup, Microsoft has greatly improved the onboarding procedure so this data can be used to set up a new machine (almost) seamlessly. However, many PC Pro readers tell me that they prefer using local accounts on their PCs, and what Microsoft has given with one hand, it has taken with the other. Local accounts are now much harder to set up, but ignore the cries from other tech publications who falsely proclaim that Windows 11 is online-account only. Cobblers.

Until recently, the easiest method was to sign in with one of the many well-known, yet bogus, Microsoft accounts. Variations such as test@test.com or 123@abc.com could be used with a gibberish password that forced the setup procedure to fail. Windows would then display a Local account setup dialog. This method no longer works on the latest versions of 11, so what does? Well, it depends on hardware and software configurations.

Whether you're setting up a factory-fitted OEM of Windows, or rolling your own using the Microsoft Media ([tinyurl.com/361msmedia](https://tinyurl.com/361msmedia)), you'll hit a point during setup where internet credentials are requested. If you're on a desktop without Wi-Fi, then disconnect the Ethernet cable before you begin. When setup arrives at the connectivity page, click the "I don't have internet" and proceed to set up a local account. Easy.

If your PC has a Wi-Fi adapter, then Microsoft expects you to use it, and the "I don't have internet" option doesn't appear. This remains true even if no working Wi-Fi is available. The trick at this point is to press Shift+F10 (or Shift+FN+F10 on certain laptops) to open a CMD window. Type (without spaces) oobe/bypassnro and the machine will restart. You'll need to repeat a few setup steps but when you hit the connectivity page, "I don't have internet" will have magically appeared.

If you're finding that Shift+F10 (or Shift+FN+F10) doesn't open a CMD window, then that's because the cheapskates who built your laptop loaded it with Windows S and CMD can't run. Sadly, the path to a local account is to use a Microsoft account to get the machine running, upgrade the machine (for free) to Home edition, then perform a



full factory reset. You'll now be able to use the shortcut keys as above.

Which is a reminder that there's just time for you to enter a competition. Simply answer the following question in no more than four letters: "I think the 'S' in Windows S stands for...". All answers to be emailed to [s.nadella@microsoft.com](mailto:s.nadella@microsoft.com), and the lucky winner will be the one that avoids prosecution.

If this all sounds like a huge faff, then Rufus ([rufus.ie](https://rufus.ie)) can be used to build a bootable ISO with selection options to create local accounts and also bypass W11 hardware requirements. If you want an easy way to install Microsoft's latest on unsupported hardware, Rufus is your friend.

### PC Pro (almost) presents: the self-disassembling PC

I was intrigued to read iFixit's recent report ([tinyurl.com/361ifixit](https://tinyurl.com/361ifixit)), which gave the new Surface Copilot+ devices a 7/10 repair rating. The Surface Laptop 7 seems to be easily accessible, with a few screws holding things together, but the Surface Pro 11, a tablet, still requires lots of heat and prising to get the screen off. This certainly doesn't seem like a 7/10

**ABOVE** Self-removing Surface Pro screens are a feature that should be replicated

**"The screen had come away because the battery had failed then swelled inside the case"**

**BELOW** Despite what others may tell you, you can still use a local Microsoft account

rating to me. Recently, a Surface Pro 4 arrived in the shop featuring a technical innovation that Microsoft should endeavour to replicate: the self-removing screen.

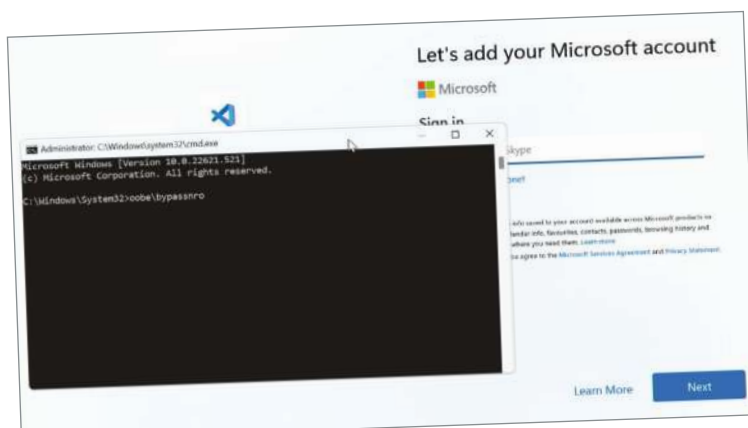
The screen on this Surface had come away because the battery had failed then swelled inside the case. The owner only realised this after pulling off the screen, which severed both the touchscreen and digitiser cables.

Somewhere along the line, this Surface had been encrypted by BitLocker, but the recovery key had long since vanished. The device used a local account for login, so this key wasn't stored online ([tinyurl.com/361bitlocker](https://tinyurl.com/361bitlocker)). The customer had already been shopping in the bargain aisle of MS-parts-R-Us.com and provided me with a battery and one cable.

Despite the battery's bid for freedom, it's still a task to get these out as it's one of the first components used and everything else is built around, or on top, of it. I fitted the battery, the solitary cable (luckily it was display, so no touch) and bent the malformed heatsink back into shape. The device started and I was able to log in and access the data. At this point I spotted that the customer's premium-quality, non-specific branded, three-for-£1 bargain-battery was faulty. Another reminder that spare-parts don't always work.

The customer was pleased to get the data and told me to scrap the Surface Pro as he had bought another, which would have been nice to know before I'd fought to replace the battery. If you want a "for parts" Surface Pro 4 with two knackered batteries, it's in our e-waste skip, help yourself.

[lee@inspirationcomputers.com](mailto:lee@inspirationcomputers.com)





OLIVIA WHITCROFT

# “Every different use of personal data about someone needs a lawful basis”

**While the term “lawful basis” may fail to excite, it’s a rule that’s making the likes of Meta think twice before using your data to train its AI**

I’m speaking at a conference in September on “picking the right lawful basis for your processing activity”. Don’t stop reading! I agree it doesn’t sound that enticing, but I promise there is excitement ahead.

Every different use of personal data about someone needs a lawful basis, and you have six options. Your activity must be necessary for a contract with them, a legal obligation, vital interests (life or death), a public task, or legitimate interests. The sixth one is the individual’s consent. The tricky thing about consent is that it must be freely given, specific, informed and unambiguous. A tricky part of the others is that word “necessary”.

In my preparations, I started rolling out some quick examples for my delegates: “We collect employee PAYE details to send to HMRC” (*easy – legal obligation*). “We use our customers’ addresses to send them the product they’ve bought” (*easy – contract*). “We need property details to calculate Council Tax” (*easy – public task*).

Next, some scenarios that give pause for thought: “We share information with the police to help with investigations.” If there’s a statutory duty or court order then it’s a legal obligation. If not, perhaps legitimate interests, but you need to balance those interests against the interests of individuals. A new lawful basis of “recognised legitimate interests” was proposed under the Data Protection and Digital Information (DPDI) Bill, with no required balancing act. But then an election was called and the Bill was dropped, so its fate is in the hands of our new government and its Digital Information and Smart Data Bill.

“We use customers’ email addresses to send newsletters.” This could be contract (if part of an agreed service) or maybe legitimate interests; otherwise consent is probably needed. The UK



Olivia is principal of the law firm OBEP, which specialises in technology contracts, IP and data protection  
X @ObepOlivia

**“For consent to be freely given, users must have a real choice”**

**BELOW** Experian has been involved in a long-running dispute with the ICO

Information Commissioner’s Office (ICO) has been in a long-running dispute with Experian about the use of legitimate interests in the context of direct marketing activities (a topic I discussed in issue 351). In April 2024, the Upper Tribunal confirmed the First Tier Tribunal’s decision supporting the use of legitimate interests for Experian’s activities, highlighting the relevance of benefits to individuals (as well as potential detriments).

Finally, I braved some really thorny hot topics. “We use personal data to push targeted adverts based on behaviours” (*hard*). “Personal data is analysed by our artificial intelligence models” (*help!*). How “necessary” are these activities, and is “legitimate interests” even an option? If you seek consent, how can you ensure it is freely given and informed?

## Meta has tried them all

Meta has had a tough time finding a lawful basis for its behavioural advertising activities on Facebook and Instagram in the EU. When the GDPR first arrived, it sought to rely on such advertising being necessary for a contract (for services) between Meta and the user, based on the terms of

service. However, this faced the challenge that behavioural advertising is not objectively necessary to provide its social networks. In 2023 it put forward legitimate interests: a positive user experience and generating revenue (from advertising payments), among others. This was contested on the basis that the interests of users overrode Meta’s interests.

The challenges culminated in a binding decision of the European Data Protection Board in October 2023, instructing the Irish Data Protection Commission (DPC, Meta’s lead EU supervisory authority) to ban Meta’s use of data for behavioural advertising on the basis of contract or legitimate interests, which the DPC did by an enforcement notice in November 2023.

So Meta changed its lawful basis to consent. For consent to be freely given, users must have a real choice. If saying “no” means you’re denied access to Facebook, a prominent global platform with over three billion monthly active users, then you’re being strongly pushed towards consenting, and it isn’t really freely given. Instead, Meta adopted a “consent or pay” model. If you don’t want to receive the personalised adverts, then you can pay a monthly fee for access to the service.

The EDPB once more put their heads together and, in April 2024, adopted an Opinion on this model in the context of large online platforms such as Facebook. Its view is that consent cannot be said to be freely given, as users will still be under pressure to consent, where the alternatives are either not to access the service or to pay a (possibly disproportionate) fee. There needs to be an equivalent alternative for those who don’t consent, such as perhaps receiving adverts that are not based

on analysis of personal data.

In July 2024, the European Commission gave the view that Meta’s model was also in breach of the EU Digital Markets Act (which requires large players in the digital sector to play fairly).

## UK consent or pay

In March 2024, the ICO called for views on “consent or pay” business models in the UK market. It considers that, in principle, data protection law doesn’t prohibit these models. But it outlined four areas to consider in assessing whether a consent is valid: the power balance between platform and user; the equivalence of the ad-funded





service to the paid-for service (so without “premium extras” if you pay); an appropriate fee; and privacy by design, including clear and equal presentation of the choices.

So let’s say you’re a small platform, with plenty of competitors and choice for users. In order to keep running, you need a source of income. You calculate the revenue you would receive from targeted advertising and work out an equivalent service fee. You then clearly present users with two options to access the platform: consent to behavioural advertising or pay the service fee. On the face of it, this seems similar to Meta’s model. But your low market power, fairly calculated fee and clarity over the options could lead to freely given consent in this context.

## AI and legitimate interests

In May 2024, it was reported that HMRC was hiring customer services personnel using AI, without the applicant ever speaking to a human. This implied the AI was analysing personal data and making recruitment decisions. I scoured the web trying to find a privacy notice identifying HMRC’s lawful basis for these activities, to no avail. So I made a freedom of information request to try to find out. My initial request was lost in the ether, so there was a delay in HMRC pressing “Go” on its stopwatch for the 20-day response period. I then received a fairly cryptic response that was silent on lawful basis, but seemed to say AI wasn’t used in the process to the extent reported. Now I’m grumpy that I’m no further forward on this.

There are (at least) two key processing activities to consider in using AI models in this way. First, the use of personal data to train the model. You may, for example, use data about good performers among your existing employees to train the AI what to look for. Second, the AI will process personal data about applicants to assess suitability for the role and potentially make the decision whether to recruit.

## Training the model

An interesting decision of the Belgian data protection authority in March 2024 concerned the use of personal data to train a data model. An English-language summary and machine translation has been reported in GDPRhub ([gdprhub.eu](https://gdprhub.eu)) run by the privacy rights group NOYB ([noyb.eu](https://noyb.eu)). The authority decided a bank could rely on legitimate interests to use customer transaction data to train its model offering tailored customer discounts. Building the model for this marketing purpose was a legitimate interest, and

analysis of transaction data was necessary to achieve it. The balancing test took into account that the model involved low-risk data, it wasn’t used to identify customers, and no personal data was shared externally.

The ICO also envisages the use of legitimate interests as a lawful basis for training models in its AI guidance. It flags the need to properly define the purposes and justify use of each type of data.

An organisation must demonstrate that the range of variables and models it intends to use is a reasonable approach to achieving the outcome. The mere possibility of usefulness is not enough to be “necessary”. Assessments may need to be re-visited over time as purposes are refined, or if an individual exercises their right to object to processing based on legitimate interests.

And, of course, Meta is at the forefront of this as well. In June 2024, it updated its privacy notice to include use of user data to train generative AI technology, on the basis of legitimate interests. But NOYB immediately filed complaints with 11 EU data protection authorities. In the UK, the ICO has asked Meta to “pause and review” its plans.

## Deployment of AI

Deployment of AI should be considered separately. If the AI is making a decision without human involvement and which significantly affects an individual (such as whether to recruit them, offer them a loan or give them access to a service), then this is only lawful if the decision is necessary for a contract with the individual (or for entering into a contract), required or authorised by law, or based on explicit consent. So legitimate interest is not

**ABOVE** Meta has struggled to find a lawful basis for its ads on Facebook and Instagram

**“You need to pick the right activity, and the lawful basis will fall into place with it”**

**BELOW** HMRC has reportedly used AI to hire staff



available. Though it is another area that was set to be relaxed under DPDI, and we await to see whether this is revived.

Both the EDPB and ICO have provided examples of using solely automated decision-making to sift through large numbers of applications during a recruitment process, but the guidance on lawful basis doesn’t appear clear or consistent. And real-life examples are surrounded in mystery, such as the HMRC story. The EDPB indicates that the sifting process can be considered necessary for entering into the employment contract. The ICO says that the contract basis can only be used at the job offer stage, so is it implying that explicit consent may be an option at an earlier stage? Consent needs to be informed and freely given, so individuals must have clear information about the role of the AI, and an option to say “no” (without being put at a disadvantage).

For AI that doesn’t make such decisions (or if there is meaningful human involvement), legitimate interests could be considered, and the balancing test is needed. Factors such as the quality of training data and the risk of bias should be factored into this.

## Data protection by design

Coming back to the title of my conference presentation, I think it’s topsy-turvy. It’s not a matter of deciding what you’re going to do and then picking the right lawful basis. That way, you may be unable to find one at all, as Meta is finding with its behavioural advertising activities, or if you leap into using AI to make significant decisions. Data protection by design means designing what you’re going to do in line with data protection rules and rights. So, rather than picking the right lawful basis, I think you need to pick the right activity, and the lawful basis will fall into place with it.

[olivia.whitcroft@obep.uk](mailto:olivia.whitcroft@obep.uk)



DAVEY WINDER

# “I made the mistake of telling the truth and got an inbox full of emails from conspiracy crazies”

**Davey delivers his verdict on the CrowdStrike fiasco and explains why the breach of supposedly 10 billion passwords wasn't quite what it seemed**

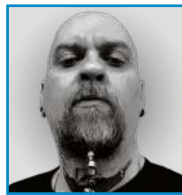
**A**s the dust settles over what has been one of the most disruptive IT failures ever, the funky CrowdStrike update that blue-screened more than 8.5 million devices across the planet, it's a good time to reflect on what actually happened. Yeah, I know, “disruptive” undersells it a tad, but cluster@!& was deemed editorially unacceptable.

Call it what you will – CrowdStrike, ClownStrike or, my personal favourite because I coined it, the IT CrowdStrike – the incident was the single most significant cause of tech disruption since WannaCry back in 2017. It was also, perhaps inevitably, the biggest source of technical misinformation since social media made everyone an expert on everything. I mean, seriously, where did all these so-called endpoint and cloud security experts come from?

Days after the incident, days after the official technical explanation of what happened was published by CrowdStrike itself, days after real experts and clued-up journalists had explained the truth, people were still laying the blame at Microsoft's door. I get that end users presented with the dreaded blue screen of death might think that, even non-tech executives, but techie types?

In a *Forbes* news story at the time, I made the mistake of telling the truth, stating that “the blue screen of death is the effect, but a CrowdStrike update was the cause of the global IT outage,” and got an inbox full of emails from the conspiracy crazies for my troubles. Undeterred, let's try again, shall we?

CrowdStrike is a cloud-native security platform that's aimed



Davey is a journalist and consultant specialising in privacy and security issues  
X @happygeek

**“Where did all these so-called endpoint and cloud security experts come from?”**

**BELOW** Davey's preferred term for July's event is the IT CrowdStrike, for obvious reasons

squarely at protecting enterprises from malware, zero-day attacks and ransomware. The company describes itself as securing “the most critical areas of risk – endpoints and cloud workloads, identity, and data – to keep customers ahead of today's adversaries and stop breaches”.

At the heart of CrowdStrike's offering is the Falcon platform. This brings antivirus, endpoint detection and response, threat intelligence and threat hunting together within a minimal footprint “sensor” delivered and managed via the cloud. Given that CrowdStrike exists to prevent breaches, exploits, attacks and downtime (oh, the irony), it should be pointed out that what happened was not malicious, not a cyberattack.

Instead, it was the result of a dodgy sensor configuration file update that was pushed out to all customer systems running Windows. The file itself is what's known as a channel file, an essential component in the Falcon behavioural protection mechanism and routinely updated several times a day to ensure customers are protected against newly discovered “novel tactics, techniques and procedures”.

The faulty file was released into the wild at 5.09am UK time and immediately started triggering a logic error that caused impacted systems to enter a boot loop and display the

dreaded blue screen of death. That rogue file was “remediated” at 6.27am the same morning.

Those 78 minutes were long enough to take down an estimated 8.5 million Windows devices, according to Microsoft, which was keen to point out that this represents less than 1% of all known Windows devices. However, to put that into real-world context, the devices affected disrupted services at multiple airports and airlines, emergency services such as 911 in the US, healthcare including GP surgeries and some NHS services, banks, the London Stock Exchange, media including Sky and the BBC, public transport including train operating companies, supermarkets and, well, you get the idea. Any systems running Falcon sensor for Windows 7.11 that was online during those 78 minutes was doomed.

Even more precisely, any system that downloaded channel file 291. C-00000291\*.sys is found in C:\Windows\System32\drivers\CrowdStrike on Windows systems but – as Jon explains from p108 – it isn't a kernel driver. In fact, it controlled the evaluation of a named pipe execution, pipe1 in this case, used for bog-standard communications in Windows. Specifically, channel file 291 was released to target newly discovered maliciously named pipes in use by command-and-control frameworks deployed by threat actors. Systems running Linux or macOS, which don't use channel file 291, weren't directly impacted. This is what likely caused many to assume this was a Windows problem rather than anything else.

But, as we all know, to assume makes an ass out of u and me. And talking of making an ass of oneself, a few days prior to the incident CrowdStrike had published a state of application security report that warned updates to software



**Update as of 10:30 UTC on 19 July 2024:**

We have received reports of successful recovery from some customers attempting multiple Virtual Machine restart operations on affected Virtual Machines. Customers can attempt to do so as follows:

- Using the Azure Portal - attempting 'Restart' on affected VMs
- Using the Azure CLI or Azure Shell (<https://shell.azure.com>)

<https://learn.microsoft.com/en-us/cli/azure/vm?view=azure-cli-latest#az-vm-restart>

We have received feedback from customers that several reboots (as many as 15 have been reported) may be required, but overall feedback is that reboots are an effective troubleshooting step at this stage.

**ABOVE** Try turning it off and on again and again and again and again...



applications were only reviewed by cybersecurity teams 54% of the time. In fairness to CrowdStrike, it was referring to "major updates" rather than channel files such as this, but it's still a bad look in the circumstances and opens the organisation up to claims of not eating its own dog food.

As Jason Schmitt, general manager of the Synopsys Software Integrity Group, said: "This is a reminder that we live in an increasingly digital world in which software underpins nearly every facet of our lives – from transportation and emergency services to banking, retail and even food services."

He added: "While this outage appears to be the result of an error or honest mistake, businesses also have to contend with the reality that cybercriminals are actively seeking to compromise or disrupt their software systems for financial gain or other nefarious purposes. Establishing secure and resilient software development practices is now a critical business requirement."

One has to hope that in the weeks and months to come, and the sooner the better if CrowdStrike is to retain trust with customers, lessons will be learned as to exactly what went wrong to allow such an update file with that logic time bomb to be passed for distribution.

There's no point at this stage in me going over the methods of mitigating the problem as you'll have taken care of business by now, or you'll have no business. However, one Microsoft bulletin suggested that customers using Azure virtual machines should try turning them off and on again, as much as 15 times – hence my IT CrowdStrike comment. Well, you've got to laugh. Haven't you?

## RockYou2024 doesn't rock me that much

Moving on from the world's biggest IT outage, I thought I'd explore the sale of what is being touted as the world's largest collection of stolen passwords on an infamous dark web criminal marketplace.

The story starts in 2021, when a database of 8.4 billion leaked or stolen passwords was offered for sale, going by the name of RockYou. Fast-forward to now, and an updated version creatively titled RockYou2024 has emerged. An initial analysis of the database suggested that this took the credential treasure chest to a smidge under 10 billion. To be precise, 9,948,575,739 unique passwords, all in plaintext format.

## Statement from our CEO

Sent 2024-07-19 19:30 UTC

Valued Customers and Partners,

I want to sincerely apologize directly to all of you for the outage. All of CrowdStrike understands the gravity and impact of the situation. We quickly identified the issue and deployed a fix, allowing us to focus diligently on restoring customer systems as our highest priority.

The outage was caused by a defect found in a Falcon content update for Windows hosts. Mac and Linux hosts are not impacted. This was not a cyberattack.

We are working closely with impacted customers and partners to ensure that all systems are restored, so you can deliver the services your customers rely on.

CrowdStrike is operating normally, and this issue does not affect our Falcon platform systems. There is no impact to any protection if the Falcon sensor is installed. Falcon Complete and Falcon OverWatch services are not disrupted.

We will provide continuous updates through our Support Portal at <https://supportportal.crowdstrike.com/s/login/>.

Well, that was the claim, with the 2024 database supposedly added 1.5 billion new passwords to the mix. I say "new", but like the original these were passwords that had been scraped together from known breaches, collections of passwords previously sold, and covering two decades in all. The original researchers said that RockYou2024 "is a compilation of real-world passwords used by individuals all over the world" and its availability "substantially heightens the risk of credential stuffing attacks".

But does it? Even if there were 10 billion passwords here, or 20 billion for that matter, such wordlists only affect those who reuse their passwords across multiple services and aren't making use of multi-factor authentication protection. I know that sounds harsh, but if your passwords aren't unique, are weakly constructed, and don't have an additional authentication factor to protect them, then your accounts are already parading around with crosshairs upon them – it's only a matter of time before someone finds a way in.

Not that I think there are anywhere near 10 billion unique passwords in this database compilation – and I'm not alone. I've spoken to several security professionals who have dug into the data and found what one described as "hot garbage" and another as "a word search on steroids".

**ABOVE** The CrowdStrike CEO's apology doth butter no parsnips

**"You'll have taken care of business by now, or you'll have no business"**

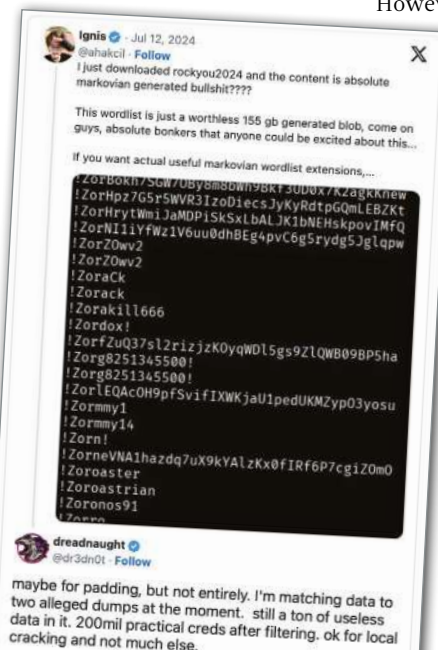
**BELOW** Security researcher calls password database "markovian generated bulls\*\*\*\*"

A spokesperson for the team at the online publication Cybernews ([tinyurl.com/361cybernews](https://tinyurl.com/361cybernews)) that originally found the database on the dark web told me: "Our researchers have been in contact with the threat actor who published the file with the data and provided proof of around 30GB of combo-lists from which data was extracted."

They went on to say that while the Cybernews research team didn't investigate all the datasets thoroughly, "researchers were able to map the values between the provided combo-lists and a part of the RockYou dataset with a 100% match. Our aim is to inform the public about potential risks, not to pass the dataset to threat actors for use. Thus, we cannot confirm or deny your mentioned claims from other hackers/researchers."

However, Ata Hakcil, the team

leader at cybersecurity tech researchers WizCase, took a deep dive and concluded it was a mixed bag of nothing. Hakcil started off by examining the character length of the password list and discovered that rather than averaging out at the nine to ten characters you would expect, there were plenty of peaks in excess of 100 characters. Far in excess, in fact. Sure, some people (guilty) have ridiculously long passwords, but 10,000+ with 175-character passwords? Thousands more in excess of 200 characters? Check out the





Continued from previous page

graph in the WizCase report ([tinyurl.com/361wizcase](https://tinyurl.com/361wizcase)) and you'll see how unlikely it is that millions, billions even, of these entries are real passwords, in Hakcil's opinion.

He found 70 million lines of pure junk, including strings too short to be passwords and lines containing unreadable characters. "The most intriguing (and frankly, concerning) aspect was the abundance of entries that resembled what password-generation tools might produce," said Hakcil, and WizCase would know as it's created such a password generator itself. Indeed, with many looking like they've been scraped from password-generation tools, the value of those strings becomes highly questionable as they're unlikely to be found used in the real world.

"We should all be concerned about low-quality AI content muddying datasets like wordlists and making them less useful," Hakcil said, "especially when the intention is to use that dataset for good."

Rainbow tables, or traces of them, were also found. These are indices containing hashed and plaintext password versions, and are definitely used by bad actors with password-cracking tools. However, Hakcil found that in RockYou2024 they were formatted in such a way, on single entry lines, so as to be unreadable by those tools. But a quick script would soon sort that out, right? Well, yes, but even then it appears that the plaintext passwords were "gibberish" and still useless. "This suggests they're junk that was added to pad the leak and make it seem bigger," Hakcil concluded.

None of which is intended to undermine the work of the original researchers in bringing RockYou2024 to the attention of a broader audience. Anything that gets people thinking about their credential hygiene is a good thing. Credential stuffing is very real, and if this encourages people to look at using a password manager to create unique random passwords as well as employ MFA for additional protection, then great. But facts also matter, and the story becomes a lot better when the data is drilled into.

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STEVE CASSIDY

## "I felt positively embarrassed to get my gear bag out when a flock of trolleys was nearby"

**After a stint as an in-patient at a London hospital, Steve has a few radical ideas about the use of on-trolley PCs**

**I** have recently discovered that I am not a hospital person. Partly this was caused by visiting a sick relative, but mostly it was brought on by a few days being fixed up and then cared for on a ward crammed with patients, nurses, doctors, families and hangers-on, porters, catering staff – the food was pretty good, incidentally – and the occasional scribbler in suffering. Actually, it can't have been so bad, because I was utterly hypnotised by what the nurses were using as an IT system.

Each nurse had a trolley – nothing new there, you might say. Except that these trolleys were topped off by a 24in widescreen monitor and adorned with a massive steel shelf, just at arm height, where the keyboard, mouse and sundry paper printouts were to be found. Oh, and a little barcode reader, to pick up the data on the wristbands of their patients.

I felt positively embarrassed to get my gear bag out when a flock of trolleys was somewhere nearby; for a bit of in-patient chic I had brought my Toshiba WT-20c Windows 10 tablet. This is an unusually broad and cleverly designed separable, with a gorgeous hi-res screen and a little hidden pen nestled in the base. I couldn't find the accompanying keyboard, which was a shame, but on the other hand, as a naked tablet, I paid £55 a unit.

And it works. Looking at the nurses with their Dalek-like trolley, I was forced to wonder, what would be so terrible about making use of a smaller, more personal device and display? Sure, there was a need to connect some peripherals like the barcode reader, but the payoff in improved mobility and battery power (most of the trolley's cargo seemed to be regular 240V mains powered, so the only way these things were



Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart  
X [@stardotpro](#)

**BELOW** Each trolley in the ward was adorned by a huge 24in monitor



truly mobile was with some kind of on-board battery to drive the big screen) was surely worth it.

My shame at losing out in the "size matters" stakes was rapidly dissipated by the first ward round, when the senior doctor toured the ward with a gaggle of students, and an outer ring of trolley-pulling nurses. They actually had proper trolley jams whenever more than three nurses were clumped together to hear the senior man's words. It seemed absurd to me that the ward was almost crammed full of display screens already, on separate blood-pressure-sampling devices or as pay-per-view TVs hanging over every bed. With a few minutes of hackery, I could drive such devices as secondary screens from my humble Tosh, via Miracast services in Windows 10 and 11.

With a little more work, I could have a Tosh-sized device on a shoulder strap, almost unobtrusively sitting a few inches below the armpit of the user.

Was I the only person there, I thought, who remembers the days of "wearables"? To me, the information on the 24in screens the carers were toting could be divided between VR glasses or goggles for the practitioner, and the aforementioned Miracast-driven general-purpose screens up on the walls. I'm not proposing a new use for all those face-covering helmet style VR systems: I'm harking back to some of the less intrusive efforts, which look like a regular pair of specs with the lenses either left out entirely, or present as a thin translucent film.

Beside manner depends quite a lot on eye contact, so dressing up your nursing staff as robot zombies is probably worse than having them accompanied by a seven-foot tall Dalek drug dispensary.



## The real meaning of “business continuity”

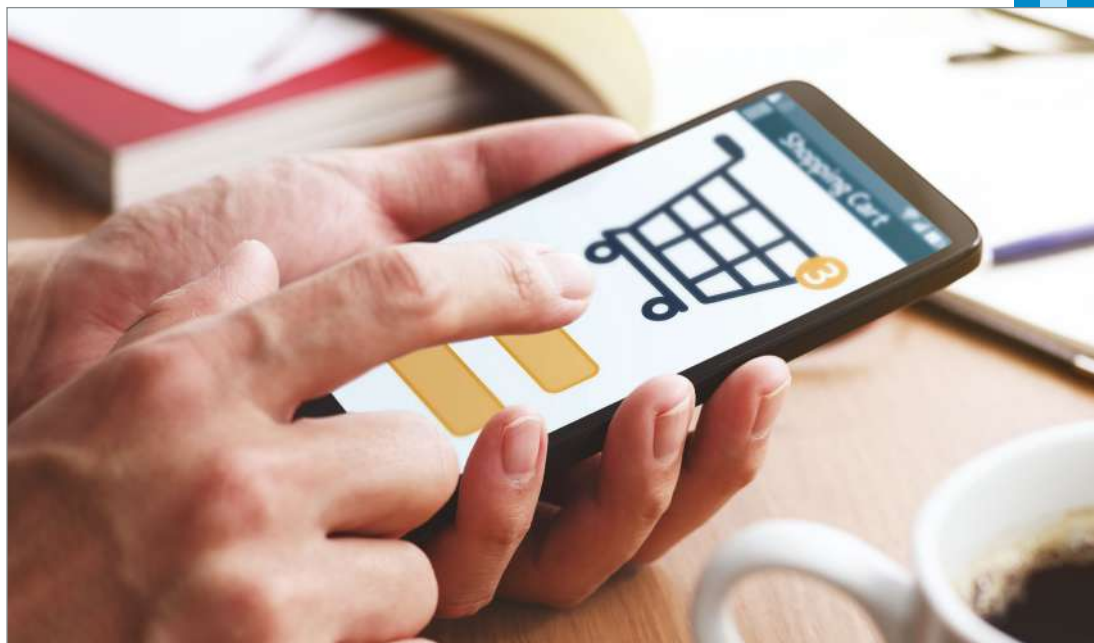
A lot has already been written about the global service outage on a lot of cloud services at the end of July. It's unfortunate that the finger has been pointed at Microsoft when the confessions from management and workers at CloudStrike have been frank and public. No mysteries here, no cabal of shadowy hackers to blame: by far the biggest interruption to service came from a fairly simple mistake in operational support. The basic problem was how convoluted and difficult it proved to get the various affected machines and apps back in a working state.

I suffered directly from this outage: it took out the NHS systems that stitch together GP prescription issuers and sundry prescription-handling pharmacies. This caused my GP's practice pharmacist to hand-write (oh, the horror!) a prescription, have it personally signed by the duty GP, and then call my partner to come and physically collect it. We made jokes about “back to the 1970s” until my partner turned up at the pharmacist's to find that the young man on duty had probably not dealt with non-internet delivered prescriptions before. Incredibly, he treated the lump of green paper with ballpoint pen scribbled on it as a suspicious article, and eventually handed over only one of the four items on it.

This was not, by anybody's definition “business continuity”. Not for the supplier, not for the doctor, and certainly not for me. We have become used to the idea that BC and DR (aka disaster recovery) are matters strictly for the IT team, so that whatever the tech issue it will be solved and service restored as soon as possible.

Since that definition crystallised, the business has permeated the technology just as much as the technology has permeated the business. Eventually, if you follow the siren's call, you and your customers will be drawn into an invisible web of dependencies, designed by app and service programmers whose world does not include the possibility of catastrophe.

The CrowdStrike story contains some considerable complexities, and a few parts where the censor's big black pen will descend, lest we give away too many secrets to hackers. And Jon (see p110) and Davey (see p118) have covered it in some detail in their columns. So I'm going to offer you a simpler case study.



**ABOVE** Rebooting kit in the middle of a transaction can cause serious problems

**“It shows how far apart the worlds of cloud developers and businesspeople can be”**

**BELOW** When the CrowdStrike outage hit, the chemist was left flummoxed

It concerns an old client, whose accounting team had a separate developer on contract, and a remit to enable the company website to take orders that fed back into the accounting database, from which invoices were made. What these guys wanted was an open incoming access, from the web servers to the accounts system, so that any time a customer clicked ‘Buy’, in would come the triggers to produce and post them an invoice. Simple, they cried. Over our dead bodies, we replied.

Here's the problem, we explained. The systems you're passing through to make this connection all have their own configurations, which demand the occasional reboot. No mechanism was included to pass back a “stop” order to the web servers; transactions that were generated during a firewall or accounting server reboot were simply lost in the ether. No retry mechanism, no queues: just keep that link open 24/7 and we'll be fine, old boy. Except when we came to the inevitable

moment when a router reboot was mandated; then their blind-sent transactions would be blasted to an address that simply isn't listening.

We came up with a different way of doing the job, which allowed us to do reboots of the kit we were looking after without losing track of the web-generated transaction queue. We did this by shifting the active party from the external web server pushing, to the internal accounting server, pulling. That overcame everyone's objections, at the occasional cost of a couple of minutes' delay from order to invoice.

Don't take that simple example as a literal translation of the CrowdStrike/Microsoft problem. It simply shows just how far apart the worlds of cloud developers and businesspeople can be, even at the simple stage of automating a process previously done with printed spreadsheets and yellow highlighters as the accounts team worked through that day's orders. From a disaster recovery perspective, the accounts people were confident

they could get the highlighter pens back out at the first hint of trouble, though they didn't have a plan for the kind of widespread chaos across many contributing systems that arose from CrowdStrike's operational error: there's not much point scrabbling for the marker pens if your customers can't raise a purchase in the first place.

I'm very tempted by the idea that the term “professional” should



be revised, to include the statement “someone who knows how to do the job without use of a computer”, and that’s not just me having a fit of pique thinking about my chemist and the refused prescription. As cloud services remove skills from our companies and normalise everyone’s working practices, we must be able to make innovative decisions while times are both hard, and changing fast – decisions that by their very nature are unexpected and new.

Preparing for eventualities whose descriptions and effects seem guarded by an opaque curtain of nerd-speak is a 21st century challenge for the modern businessman. For the IT professional like me, it’s a case of back to the old school, because it would be a very unusual contingency plan that didn’t include a few extra or upgraded machines in the office, synchronised in terms of the records they contain, but not in terms of the software used to access those records.

If your software guru is spluttering in outrage at such a revolutionary suggestion, I commend them to take a look at the database-sync abilities of FileMaker Pro, or the end-user toolkits around MySQL and lots of others. You might think that various SaaS services (and that includes Microsoft 365) take an approach to customer data that’s essentially no more reassuring than a pat on the head.

## Video goes pro for amateurs

I hate social media advertising. Once, in the very early days, I was offered 25% off Puma attack helicopters in a social media advert. For me this set a benchmark in credibility (and incredibility), which helped for a while because it made me simply ignore any social media adverts, not even devoting mental resources to the “click/don’t click” decision.

This worked fine until I was in a bed on an open ward, hooked up by various tubes, very bored and dependent on my phone for entertainment. Up flashed an advert from Amazon, showcasing something that looked a bit like an over-fed iPad. I followed it and realised that what I was seeing was a live streaming, multi-camera “mixing desk”.

I followed the advert (I did say I was bored) and two things became apparent. One, I was still befuddled by



the surgeon’s anaesthetics. Befuddled enough that I didn’t bookmark the page to present it to you here. Two: someone, somewhere in China, thinks that the demand for multi-camera live streaming and recording devices is so widespread that they can charge over £1,000 for a little bit of hardware that does this job.

Streaming live video is a contentious topic. There are objections of a commercial nature and even political factors: live streamed video is associated with copyright infringement (filming the away match whose TV rights have already been sold) and even fringe political activities (fanatical followers ignore mainstream news media and live solely on a visual feast of streamed, real-time coverage by self-admitted partisan producers).

There’s also the vexed question of interactivity. One of these multi-camera, tablet-format devices can present five distinct video feeds, leaving the viewer to decide which one gets the big window and which are relegated to the thumbnail rail. This doesn’t sound like a problem,

**ABOVE** Live streaming is no longer the sole preserve of video pros

**“Once, I was offered 25% off Puma attack helicopters in a social media advert”**

**BELOW** Tablets that can live stream using multiple cameras are now commonplace

until you sit down and have a chat with someone who’s worked in old-school media.

One of my hospital visitors is one such: a video media professional, very interested in the rules of production. She’s firmly in the club that says just because modern tech can receive five simultaneous feeds, there’s no guarantee that the audience can repeat the benefit of that technology.

Her research came from a slightly different time, when all the camera firms produced 360-degree panoramic cameras, leaving the audience to pan, tilt and zoom the data feed on the receiving viewer, rather than leaving those moves to the decisions of the film-maker. It turns out, she said, that people far prefer to be told a story, rather than having to find it for themselves.

That’s not the absolute death-knell for a five-camera pocket edit desk that costs you a bag of sand; even a basic face-to-face interview setup or Zoom call can gain in credibility with a variety of shots. Think long-shot panoramic views, close-ups on faces and mid-range shots that reveal

things such as hand gestures, hair-flicking, nail-chewing and so forth.

A few years ago we would have thought that a specialised, dedicated tablet device doing this job was an unnecessary thing, a toy for the hobbyist. Suddenly, streaming has come of age, in ways we could not see coming even five years ago.

cassidy@well.com





# RETRO



Inspirational stories from computing's long-distant past

## Taking computers to the NeXT level

When Steve Jobs left Apple he hoped to make a big impact with computers for education. But NeXT ended up teaching the computer industry a thing or two instead, as **David Crookes** explains

In summer 1985, Apple co-founder Steve Jobs rebuffed three offers to become a professor. "I told all of the universities that I thought I would be an awful professor," he later revealed in an interview with *Newsweek*. Yet he still wanted to make a big impact in the education sector.

Jobs was 30 years old and ready for a new challenge. He'd resigned from Apple following a reorganisation, but not before telling the board what he wanted to do next. Having previously visited Brown University, he'd been told academics sorely wanted a powerful, personal workstation capable of helping them with their research. His aim, he told the Apple board, was to create a computer for the higher education market that best suited them.

When he made his announcement, jaws dropped, primarily because he said he was going to take five Apple employees with him. "These are very low-level people that you won't miss, and they will be leaving anyway," Jobs explained. But he wasn't entirely telling the truth.

Jobs had little love for those running Apple at the time. "I think John [Sculley, Apple's then-CEO] felt that after the reorganisation, it was important for me to not be at Apple for him to accomplish

what he wanted to accomplish," Jobs told *Newsweek*. "He issued a public statement that there was no role for me there then or in the future, or in the foreseeable future.

And that was about as black and white as you need to make things."

To that end, he didn't care that the five people he chose for his new venture were hugely important to Apple. Among them was Rich Page, one of the first four Apple fellows who had prototyped the company's first portable, colour and 68020-based Macs. At the time, Page had been working on a machine referred to as the Big Mac, a powerful workstation for use in a university lab. It was a

dual-boot machine allowing for the UNIX operating system as well as Mac OS but ended up being cancelled.

The five also included Bud Tribble, who headed Apple's software development team and helped to design the classic Mac OS and its user interface; engineer George Crow, who designed the Macintosh 128K's analogue board containing the power supply and video circuitry; and Susan Barnes, controller of the Macintosh division. Then there was Dan'l Lewin,



**ABOVE** The NeXT machine used by Tim Berners-Lee to run the first World Wide Web server

a sales executive in the Mac team who created the Apple University Consortium and bulk sold Macs to two dozen institutions, including all Ivy League universities. All were disillusioned with life at Apple.

In that respect, Jobs was being honest. His chosen few likely would have left regardless of his intention to create afresh. Jobs didn't waste much time, either. "Steve called me and I went for a long walk with him," Lewin told *PC Pro*. "He told me he was going to start a company and it was going to focus on the things that I cared about

– the things I'd pioneered at Apple from scratch.

"My thought process was that if I didn't go and the company was successful, I'd kick myself, and if I didn't go and it failed, I'd be curious as to whether or not my participation would have

made a difference. At that time, I was running the entire education side of Apple, which was two-thirds of the company's revenue – I'd built both a distribution strategy and a market framework for the higher education and research community. But I was a

**"Jobs didn't care that the five people he chose for his new venture were hugely important to Apple"**

little frustrated by what was going on inside of Apple.”

Lewin was upset that Apple’s direct sales to universities had been affected by a reorganisation and the fact that product groups had stopped sharing information, which made his work more difficult. “One of the products which mattered to me was Big Mac,” he added. “I didn’t feel like I could trust getting the things done that needed to be done at Apple.”

Jobs’ new company offered a way forward and Lewin climbed aboard.

## The next step

Apple was furious. Bill Campbell, then VP of marketing, was incensed that Jobs had hired Lewin because of the strong relationships he’d built with universities. Apple threatened to sue Jobs, who told the press he found the situation strange. “It’s hard to think that a \$2 billion company with 4,300 employees couldn’t compete with six people in blue jeans,” he said.

Yet with Lewin and the others on board, it didn’t really matter that the new company – set to be called NeXT – was short on numbers. The team’s expertise would be enough to make an impact. “We have an immense amount of confidence in each others’ abilities and genuinely like each other,” Jobs told *Newsweek*. “And all have a desire to have a small company where we can influence its destiny and have a really fun place to work.”

It helped that the groundwork was already laid. Lewin’s network ran deep and he had a great understanding of the computing needs of higher education. “It had a reputation of being a niche market,” he explained, “but I turned that inside out and said, actually, it’s a superset of the real world.”

“You have consumers who are replenished annually. You have researchers doing the most far out, extensive research on the planet. And you have these incredibly bright grad students who are pushing the edge of the envelope – they were doing fascinating, fantastic things with computers and foundation resources were funding their work. Major research institutions in the US are billion-dollar operations complete with this unique set of characteristics.”

As such, NeXT was confident that it could corner the market simply because the team knew what it would take. “We’d looked at what was going on in higher education and in primary research institutions and noted that they were using VAX machines, occasionally



an Apollo workstation and, more and more over time, Sun Microsystems’ workstation.

“But any researcher worth their salt had a budget of a quarter to half-a-million dollars to gain access to a VAX, so we were looking at what they were doing with those machines. It led us to thinking about the architecture of the computer we wanted to build.”

## Seeking perfection

It took a long time for the NeXT computer to be developed. Even in late 1986, as noted in Walter Isaacson’s biography of Steve Jobs, the company only really had a \$100,000 logo created by the American artist and graphic designer Paul Rand and some snazzy offices to show for their endeavours. “It had no revenue or products,” Isaacson wrote.

But that’s not to say it didn’t have anything of note. NeXT had secured a deal with Oxford University Press to bundle a digital edition of Shakespeare’s works with the machine, alongside the Oxford Dictionary of Quotations, a dictionary and a thesaurus – thereby inventing the idea of searchable ebooks. NeXT

had also nailed a deal with Lotus to develop a spreadsheet app for the NeXT’s operating system and enlisted other PC software companies to help.

NeXT had also hired Hartmut Esslinger. He was a master industrial designer who was being paid \$2 million a year to create a design strategy for Apple. Jobs persuaded Esslinger to wind down his contract with Apple and set him to work on the creation of a cube case with perfect 90-degree angles and

foot-long sides, even though it caused production problems later down the line.

Again, as Isaacson wrote, it’s difficult to get precise cubes out of tight moulds. The solution was moulds with separately created sides, but it added \$650,000 to the manufacturing costs.

Jobs’ penchant for perfection also prompted the purchase of a new sanding machine. The screws inside the NeXT were plated as well, further inflating the costs. But at least the NeXT was moving forward.

“One of the design points was putting a digital signal processor in every machine, which no-one had

ever done,” said Lewin,

discussing the more important matter of what was going to go inside that cube. He was talking about the Motorola 56001 DSP, which allowed for fast processing of large matrix calculations, enabling the generation of CD-quality sound, speech, tone detection and music.

The NeXT computer would also include a Motorola 68030 processor running at 25MHz, built-in Ethernet, a high-resolution display and, crucially, a 256MB magneto-optical storage medium. “That was a lot of storage at the time,” Lewin told us. “It was also erasable, removable and non-magnetic.”

## Powering up

One thing was clear: the team wanted to approach the higher education

market in a different way.

“We wanted to look at the personal computer sales and distribution model and the workstation application market opportunities,” Lewin said. “At the time, when you bought a PC the

operating system came with it and you’d only pay for upgrades. You didn’t pay any monthly fees.

“But in the workstation business, Sun Microsystems being the dominant player, you’d pay a monthly fee to keep the operating system alive. So we wanted the power of a workstation machine with a PC business model, bundling Unix at the core. We wanted to dismantle the distribution side of the workstation market.”

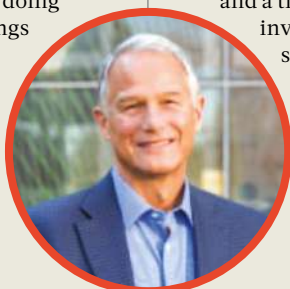
Lewin knew that universities didn’t relish having to build power plants to run workstations. “That

**TOP** Apple paid \$427 million for the NeXTSTEP OS

**ABOVE** Three years after setting up NeXT, Jobs unveiled his new computer

**“It’s hard to think that a \$2 billion company with 4,300 employees couldn’t compete with six people in blue jeans”**

**LEFT** Dan’l Lewin brought deep knowledge of the education sector from Apple to NeXT





happened at Berkeley when they got 1,000 Sun 1 workstations,” he said. “Universities also had to pay system engineers to move computers down the hall because if they physically moved them, they’d violate their terms of agreement.”

The NeXT Computer would need 300W of power. “We could help create large labs,” Lewin said. On paper, it seemed like a perfect machine which, aligned with NeXTSTEP, should have been a winner.

## Groundbreaking OS

NeXTSTEP was an object-oriented, multitasking Unix operating system based on the Mach kernel. “The distinguishing characteristic, at least in my mind, was the choice of Objective C and dynamic runtime binding,” Lewin said. “You could imagine professors building software and wanting to introduce an object into a simulation of some sort, looking at the reaction and checking what changed, and that’s what happened.”

But the graphical mouse-based operating system was hugely innovative in other ways. It introduced the idea of the Dock seen in modern Macs. It had a 3D-style interface, high-resolution icons, real-time scrolling and window dragging, fluid graphics rendering and built-in networking support. “Networking is pretty fundamental to Unix and also where the world was heading,” Lewin explained.

A few years later, NeXTSTEP also ended up giving the world what could be described as the first digital App Store courtesy of the Electronic App Wrapper, a commercial electronic software distribution catalogue that allowed users to purchase, decrypt and install apps automatically. It’s just a shame it took so long for it to see the light of day.

Jobs had wanted the NeXT Computer to be released with the operating system within 18 months. That was never going to happen, but you couldn’t fault the ambition and attempt to push development along. While work continued, there was investment – notably from Ross Perot, the founder and CEO of Electronic Data Systems and Perot Systems. Yet there were also pushbacks, primarily from Microsoft founder Bill Gates, who went as far as to call the machine “crap”, stating “the optical disc has too low latency”.

But there was beef between Jobs and Gates. Jobs wanted Microsoft to create software for the NeXT Computer but Gates didn’t want to go in that direction. There was an attempt to license NeXTSTEP to IBM instead and create a de facto rival to Windows, but that potential deal collapsed.

In the end, Jobs unveiled the machine before 3,000 people in San Francisco’s Davies Symphony Hall on 12 October 1988, some three years after leaving Apple. It came with the NeXTSTEP operating system as a machine exclusive, and Jobs, who had invested \$12 million in the company, was in a confident mood as he showed off the machine’s ability.

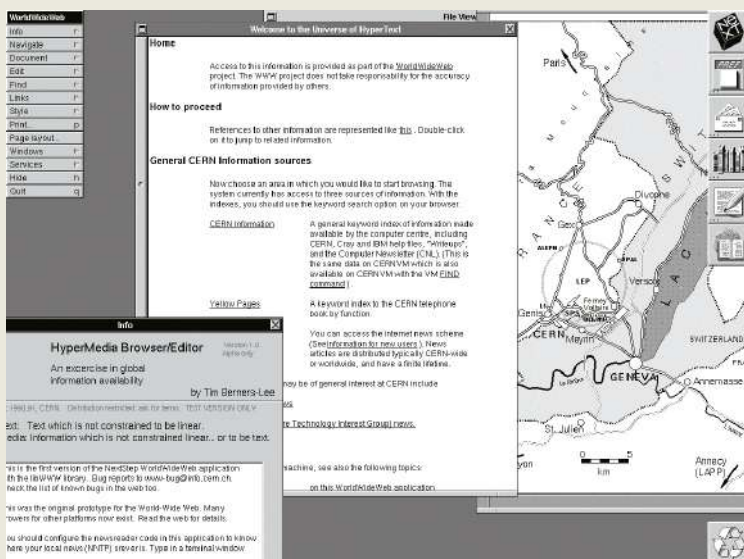
It could quickly retrieve a line from Shakespeare, he demonstrated, and capably play a duet with a real violinist. *Newsweek* said the black cube “may be the most exciting computer in years”, and the presentation earned a standing ovation. Yet the computer was a pricey little thing. Jobs wanted the computer to cost no more than \$3,000 when it was under development. It ended up selling for \$6,500, and that was with a university discount.

If buyers wanted a printer, that would cost an extra \$2,000. They’d also need to wait for version 1.0 of NeXTSTEP, which wasn’t released until 1989. But the fact that the company didn’t give up was admirable, and Jobs had a response to those who reckoned the computer was late. He told them it was actually five years ahead of its time.

## The legacy

Even so, Lewin soon became concerned. Although the NeXTcube and NeXTstation were released in 1990, the company wasn’t in good financial health. “We had \$120 million in the bank and I could see that being burned within 12 months, and that’s exactly what happened,” he said, resigning in 1991. “But in the end the asset was always software.” Other variations followed, until NeXT decided to concentrate on NeXTSTEP in 1993.

The company would go on to leave a strong legacy. British computer scientist Tim Berners-Lee created the world’s first web server and web browser on a NeXT computer at CERN, hosting the first web page in December 1990. The video games *Doom* and *Quake* were also created on the platform – developer John Carmack said id Software bought its first NeXT out of personal interest and ended up spending \$100,000 on the machines.



ABOVE The NeXT web browser created by Tim Berners-Lee

**“Jobs had a response to those who reckoned the computer was late. He told them it was actually five years ahead of its time”**

“It is funny to look back; I can remember honestly wondering what the advantages of a real multi-process development environment would be over the DOS and older Apple environments that we were using,” Carmack wrote on Quora in 2016. “Actually, using the NeXT was an eye-opener, and it was quickly clear to me that it had a lot of tangible advantages for us, so we moved everything but pixel art (which

was still done in Deluxe Paint on DOS) over.”

NeXT’s biggest legacy, however, involved Apple. In December 1996, Apple acquired NeXT for \$427 million in cash, shares, stock options and debt.

Apple wanted NeXTSTEP to become the foundation for a new Mac operating system to replace classic Mac OS. The move also heralded Jobs’ return to the company.

It meant Jobs went full circle, proving he was still able to influence Apple’s direction even when not working at the company. “If you look at the Mac today, you can trace the operating system right back to NeXTSTEP,” Lewin said. There’s the Dock, many base APIs, the Objective C runtime, the manner in which third-party apps work, and so much more.

So while NeXT didn’t prove to be hugely successful as an entity in and of itself, it had an immense impact on computing as a whole. And far from having an adverse impact on Apple, it played a large role in being its saviour. In that sense it was a successful failure, one that ultimately ended up making Jobs a household name. “It was,” Lewin said, with a level of understatement, “an interesting moment in time.” ●

BELOW The second-gen \$4,995 “pizzabox” NeXTstation



# Futures

Technologies that are set to shape the future



## Hey AI: what do my dog's barks mean?

Researchers believe AI-powered language tools could be turned from human to chat to deciphering dog barks. Animal lover [Nicole Kobie](#) reveals all

**W**oof, woof. You stare at your dog's fluffy face and wonder two things: what does she want, and how do I make her stop? AI researchers are working on a way to answer that first question so you can then figure out the second, following a grand tradition of attempting to unpick what our pets are trying to say to us.

In 2002, Japanese company Takeda launched the BowLingual dog translator ([tinyurl.com/361bowlingual](https://tinyurl.com/361bowlingual)), followed by the Meowlingual version for feline friends. By listening to the sounds your pets were making, this \$75 device would supposedly reveal its mood via an onscreen display and a short phrase (think "I'm hungry"). It was awarded that year's satirical Ig Nobel prize, but

animal translation using AI has attracted real academic attention.

A project called Zoolingua is developing an app to translate dog body language as well as building a wider data set. The Georgia Institute of Technology has been tracking chicken sounds in different situations – such as hot or cold – to understand which conditions the birds prefer. Largely successfully, it





would seem. The Project Cetacean Translation Initiative is using AI to unpick what sperm whales are saying, while the charity Wild Dolphin Project has used machine learning to try to understand dolphin speech – both of which require us to be able to think like a dolphin or sperm whale, as the *New York* noted ([tinyurl.com/361dolphin](https://tinyurl.com/361dolphin)).

So people are taking this seriously – but others aren't. A Berlin-based PR agency unveiled a new product last year called, of course, BarkGPT: “a never-before-seen web and app-based tool that uses natural language processing and machine learning to translate recordings of a dog's barks into human language.” While that marketing copy sounds exactly like the claims made by a good chunk of pet translation apps available on the mobile marketplaces, this particular example was an April Fool's prank.

It may not have seemed funny to researchers at the University of Michigan and Mexico's National Institute of Astrophysics, Optics and Electronics (INAOE) Institute, who applied models trained on human speech to animal communication – and they think they've made progress.

## ■ Decoding dogs

One of the project researchers, Artem Abzaliev, told *PC Pro* the project came about because he and his advisor wanted to apply a known type of language system to an unknown one, just to see if it would work. “My background is in visual language processing, or I guess people call it AI nowadays, but basically text understanding,” he said, such as reading a film review and understanding that the writer enjoyed the film.

Why dogs? We don't know what they're saying, so the idea was to take a system that we know works on humans and see if it could be applied to something else that has speech but isn't yet deciphered. Plus, Abzaliev likes dogs.

Beyond that, this work also addresses a core challenge with applying AI to pet communication: a lack of training data.

For wild animals, such sounds need to be collected in the wild. Pets are easier to find, but permission is needed from owners and it's time consuming.

Because of this lack of training material, analysing dog vocalisations using AI has long proved difficult, despite the many apps and efforts listed above. The researchers wanted to see if existing human language models could be applied to dog barks, after being tweaked to work with animals, of course. After all, plenty of work has been put in to understand all aspects of our speech, as that's what allows voice assistants to work.

The work required a fresh dataset of dog vocalisations, which a team at INAOE collected from 74 different dogs across a range of ages – there were puppies as young as five months – and a selection of breeds popular in Mexico, where the recordings were made. That included 42 Chihuahuas, 21 French poodles and 11 Schnauzers. The dogs were filmed reacting to various stimuli, such as their owner returning home, playing and being introduced to a stranger, resulting in the development of 14 different categories of vocalisation, including a “positive squeal” and a “negative grunt”.

That data was then used to tweak a speech representation model known as Wav2Vec2, which was originally trained on 960 hours of human speech, looking at tone, pitch and accent in particular.

## ■ Did it work?

Modifying that existing model seems to have worked to an extent, with accuracy up to 70% on one of four classification tasks. To be clear, the aim wasn't to determine what the dog was trying to “say”. Instead, researchers were trying to identify specific dogs, their breed and gender, whilst exploring the impact of context (a concept called grounding).

For dog recognition – trying to pick out which

**ABOVE** Researchers are exploring ways to interpret chicken, dolphin and dog sounds

**“The idea was to take a system that we know works on humans and see if it could be applied to something else”**

**BELOW** Even in the early 2000s, tech companies were launching products to interpret our pets

individual dog was “talking” – the Wav2Vec2 system scored 24% when used without further training, and 50% after pretraining with the dog data. Picking out breeds was trickier: the pre-trained system had a 75% accuracy rate with Chihuahuas, but that fell to 36% for poodles and 15% for schnauzers, for an overall rate of 62%. “That's not too bad,” Abzaliev said.

But for gender, the system didn't work. “We basically do as good as random,” explained Abzaliev. “Gender prediction turned out to be very hard. It's hard to do even in humans, but for dogs, even harder.”

The last task, grounding, looks at the connection between a dog bark and its surroundings, perhaps the closest classification task to understanding what a pet is trying to communicate. Here, the Wav2Vec2 system pretrained on dog sounds scored 62% accuracy.

The work raises a question: how do you even know if a dog bark translator is accurate? It's not as though the dog can correct the system the way we can with human speech models. “We don't,” admitted Abzaliev. “And it's not exactly accurate.”

## ■ Why it works – when it does

The results may not sound too impressive, but it's a leap above other models trained only on dog barks, suggesting the idea of applying existing language models to animals might be sound.

“This is the first time that techniques optimised for human speech have been built upon to help with the decoding of animal communication,” said Rada Mihalcea, the Janice M Jenkins collegiate professor of computer science and engineering, and director of UM's AI Laboratory, in a statement. ➔



“Our results show that the sounds and patterns derived from human speech can serve as a foundation for analysing and understanding the acoustic patterns of other sounds, such as animal vocalisations.”

It may seem surprising that dog vocalisations are similar enough to human speech for this to work – and Abzaliev admits the researchers weren’t themselves convinced that a language model developed for understanding human speech would work on animals. “Our expectation was that it shouldn’t work,” he said. “Dog barks are very dissimilar to human language. It shouldn’t have worked... It didn’t help completely, but it’s interesting that it helped.”

Indeed, the team isn’t even sure *why* applying a human speech model to dog barks helped at all, if even in a limited way. “We’ve had a lot of hypotheses trying to understand,” Abzaliev said, adding that the improvement in accuracy in their research over previous efforts that didn’t use a pretrained model could be down to the fact that their own system learns how to hear or listen better.

He adds that it’s not unheard of in other areas of AI. “Similar things happened in computer vision as well,” Abzaliev said. “For instance, pre-training on... one completely or relatively unrelated domain helps.”

Knowing something is better than nothing, it would seem. Even when it comes to artificial intelligence.

## How accurate?

While the results were successful in proving that repurposing existing language models has merit, how could the accuracy be further improved? More training data. This is AI after all, and AI always wants more data. “This is the biggest problem in animal communications,” Abzaliev told us. “Generally, there’s very little data.”

Large language models such as OpenAI’s GPT have plenty of written text to examine – the entire internet and more – and they still need more data to improve accuracy. But we don’t have a large dataset of dog speech; this project had samples from a mere 74 dogs. “It will need to be manually collected and manually annotated,” said Abzaliev. “It’s a laborious and time-consuming process. Data is a big, big deal.”

How can dog owners help? If you upload dog videos or sounds online, write a good caption so researchers can make use of the data. “My dog is barking because it’s happy, my cat is meowing because it’s upset,” is one example suggested by Abzaliev. “If you truly know that’s what’s happening, this would really help everyone.”



## What’s next?

There is, of course, more work to be done – this research simply showed that one language model could be applied to a different topic. The paper notes that other neural network architectures beyond Wav2Vec2 might be worth trialling, too.

According to the paper, further work is being considered around marine mammals and birds – which both have larger data sets available – and Abzaliev says the project is potentially working with capuchin monkeys. “They have a larger vocabulary size than dogs,” he explained, adding that issues around working with animals remain: “But there is also a relatively small data set.”

Abzaliev is also working on ways to convert the audio files themselves, so specific sounds can be more easily recognised in word-like ways. “Let’s take ‘I love dogs’ – there are three different words,” he said. “But we don’t even know where the words are in the bark or vocalisation.”

He added: “So I’m currently exploring models that do tokenisation for human language from audio for animal language. We’ll see if it works.”

## What’s the point?

Why do we need to know what a dog means when it barks or whines? Beyond better understanding the nature of AI language models and how they apply across languages, the UM researchers’ aim was improving animal welfare: if we can read more nuance into a dog’s bark, perhaps we can better understand its needs. This could perhaps prevent negative behaviour or health issues.

“There is so much we don’t yet know about the animals that

**ABOVE** Capuchin monkeys have a larger vocabulary than dogs

share this world with us. Advances in AI can be used to revolutionise our understanding of animal communication, and our findings suggest that we may not have to start from scratch,” said Mihalcea.

Abzaliev believes this work could help dogs themselves live happier lives. “I hope it can understand when your dog has anxiety,” he said. “I believe that not everyone understands their dogs very well. They have problems understanding ‘why my dog is barking’

**“Existing AI models can help speed along animal research, but a dog-to-person translator remains elusive”**

or ‘why my dog is crying’ or ‘why my dog behaves in a specific way’. So hopefully this can help – we are pretty far away from this, but I hope that it has at least potential.”

To be clear, none of this means you’ll be able to talk to

your dog via an app any time soon, if ever. That would require a way to decode human speech into barks, and that’s much more challenging than translating French to German. Instead, this early research is more about exploring how AI models can be applied to new tasks – and it seems that existing human language models can be applied to animal communication, though additional training using data specific to the animal in question improves accuracy. And that understanding should help those hoping to better understand chickens, dolphins and sperm whales.

So existing AI models can help speed along animal research, but a dog-to-person translator remains elusive. In the meantime, you’ll need to put the time in to figure your dog out yourself – give your dog a treat, a scratch behind the ears and take it for a walk. We don’t need AI to reveal that will likely make both owner and pooch happy. ●

**BELOW** A happy dog is usually easy to spot





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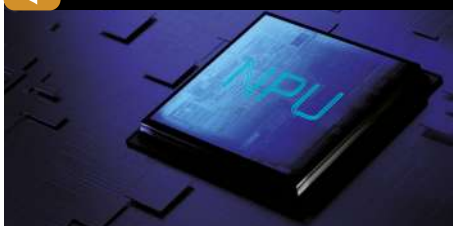
## Features



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Can you create professional-quality movies in Microsoft's free video-editing suite? We think so, and show how to use advanced visual effects, AI-powered editing and more.

## Features



### Deep dive: what is an NPU?

As more and more personal devices gain AI capabilities, we explore the hardware that makes it possible, and ask: how many TOPS do you really need?

## Labs

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With never-ending discounts, it's tempting to simply buy an Amazon Echo and be done with it. But there are many other great smart speakers around, so we find out which should make your shortlist.



## Retro

### Reload: why games on cartridges are back

We go behind the scenes at Evercade, the company that has built a thriving business of selling "games like they used to be" – on consoles, with cartridges.



## The Network



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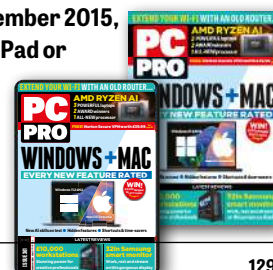
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# If governments can't stand up to Twitter, says Jon Honeyball, then it's down to us

**T**here's a standoff happening between the American tech giants and governments around the world. Google is under significant pressure in the US, with calls for it to be split up. Apple faces legal challenges from EU regulators, having recently been forced to support other app stores within the EU. Then there's the EU's new digital antitrust law, which has Meta, Google and Apple in its sights.

There is an emerging view that the historical "do it and sort out the mess later" attitude of these companies is no longer sustainable. Take training of AI engines as one recent example. Is it acceptable to scrape everything out there and stuff it into the gaping maw of an AI training engine?

But there is also another battle brewing over who controls the operation of a global social media company within a country.

Despite predictions to the contrary, Twitter (I refuse to call it X) is still going. And it's more problematic than ever. Musk's insistence that Twitter is the one true place where speech is unfettered is causing huge problems for governments, who are scrambling to control the narrative. Handling the mainstream TV, radio and printed press is relatively straightforward. Twitter, however, is not headquartered in the UK and claims to operate according to the principle of free speech as it's understood in the USA.

Twitter acknowledges it must abide by all local laws, which is lovely until we stop to consider what is meant by "local laws". I draw your attention to the fact that UK Twitter users aren't bound by a contract with a UK company, but rather Twitter International Unlimited Company, which is based in Dublin.

The reality is that this a service delivered by an American company,

as illustrated by a row going on between the user @alexandre, who is "Ministro do Supremo Tribunal Federal e do TSE" in Brazil, and Elon Musk. The Twitter "Global Government Affairs" account (@GlobalAffairs) recently posted:

"Last night, Alexandre de Moraes threatened our legal representative in Brazil with arrest if we do not comply with his censorship orders... Despite our numerous appeals to the Supreme Court not being heard, the Brazilian public not being informed about these orders and our Brazilian staff having no responsibility or control over whether content is blocked on our platform, Moraes has chosen to threaten our staff in Brazil rather than respect the law or due process."

It then announced it was closing its Twitter office in Brazil. Musk tweeted that the decision "was difficult, but, if we had agreed to @alexandre's (illegal) secret censorship and private information handover demands, there was no way we could explain our actions without being ashamed".

Yet Twitter is still available in Brazil. Closing the local office is a minor inconvenience for Twitter but not a significant win for @alexandre. Maybe Brazil can block locals from signing up to a paid-for account, but I doubt this is going to be a big financial hit.

I have no idea of the backstory between Brazil and Twitter, but it's not really relevant. Consider how Musk thrust himself into the middle of the debate over the recent rioting in the UK, saying that we were, in effect, on the brink of civil war. Really, Elon?

While no-one would claim that Twitter was a lovely garden full of flowers and bees before Musk took over, from what I can see it continues to slide into an ever worsening death

spiral of fake news, bot accounts and scattergun advertising. The controls that governments have over such platforms are almost non-existent, unless they can apply fines to a local entity. And if, as in the case of Twitter, there's nothing more than a skeletal crew in any one country, this isn't a threat that carries weight.

This raises a bunch of questions. Should our locally elected officials have top-level control over services such as Twitter? If so, how would it be enforced? Blocking the DNS at the cliffs of Dover might sound like a good idea, but a cheeky VPN tunnel gets around that in a few clicks.

**“What happens if Twitter becomes so toxic the government feels it has to take action? It can't block it. Its options are zero, and the power will fall into the hands of the people”**

The reality is that we have arrived at an inevitable impasse. This was the endpoint all along. Governments have tolerated social media platforms, and the web in general, because it was thought that the sum of benefits outweighed the negatives.

Now ask yourself: what happens if Twitter becomes so toxic that the UK government feels it has no choice but to take action? It can't block it. Unlike Google and Amazon, it can't mandate user policies for it to operate in the UK. Its options are zero, and the power will fall into the hands of the people; like all social media sites, Twitter relies on us to keep it alive. And recent events suggest that not enough of us are prepared to demand better.

■ **Jon Honeyball is a contributing editor to PC Pro. He's been watching reruns of The X-Files and believes that the truth is out there. Email [jon@jonhoneyball.com](mailto:jon@jonhoneyball.com) if you know it.**





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